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MINING LAWS OF THE REPUBLIC OF LIBERIA

BY

E. P. Youngman

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE--BUREAU OF MINES

MINING LAWS OF THE REPUBLIC OF LIBERIA[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper is one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the right of American citizens to explore for minerals and to own and operate mines in various foreign countries. In preparing this interpretation of the laws of Liberia, recourse has been had to an act passed by the Senate and House of Representatives of the Republic of Liberia, approved February 4, 1924, entitled "An Act Regulating the Mining and Prospecting of All Minerals Within the Republic of Liberia."[3] This digest is released subject to correction and amplification by the proper American foreign-service officers.

INTRODUCTION

No mining, except possibly by individual natives and Liberians (small prospectors), is now being carried on in Liberia, according to a late report.[4] No definite information is obtainable with respect to the mineral resources of the country, except that iron ores are said to be abundant. Tin, copper, zinc, monazite, corundum, lead, bitumen or lignite, and diamonds have all been reported, but no commercial deposits are known to have been found. Gold has been produced, but not in significant amounts, as may be inferred from the customs report for Liberia recording the exportation of gold to the value of $4.80 to Germany from the port of Cape Mount in 1925. It is not uncommon for natives to come into towns with African gold and valuable minerals, but they are reluctant to give information concerning them. Some years ago the Liberian Government was seeking a loan in return for oil concessions, but apparently no drilling has been done.

1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6630."
2 Rare metals and nonmetals division.
3 Acts Passed by the Legislature During the Session 1923-24, Monrovia, 1924, Chap. 24, pp. 38-47.
4 Wharton, Clifton R., Annual Report on Commerce and Industries for 1929, Liberia: Consular Rept. 333189, Monrovia, Apr. 3, 1930, Bureau of Mines foreign file 9720.

The Government has been unable to have a geological survey made of the country, and private enterprise has almost entirely neglected to investigate the mineral possibilities of Liberia.

RIGHTS OF FOREIGNERS

The mining law makes no reference to foreigners in connection with the acquiring of exploring licenses or prospecting permits; it states that "any person" may acquire such rights--the term "person" including corporations, societies, and associations that have been authorized or are authorized by the laws of the country to operate within the confines of the Republic. (Art.1, 8, and 10.)

With respect to the mining right (or concession), article 12 says that a noncitizen of Liberia must submit an application to be approved by the Legislature in the same way as are concessions for railroads and other public utilities. The application (submitted through the Secretary of the Treasury) shall contain both the Liberian and the home address of the applicant and shall be signed by the proper consul, as an indication that he has verified the name and address from records in the consulate.

Article 24 provides that should a concession be rightly applied for by a foreigner, the right granted shall be expressly understood to be the right to exploit and operate for the benefit of the Republic.

OWNERSHIP AND CLASSIFICATION OF MINERALS

To the Republic belong all mineral deposits that are found in rocks or that form part of the rocks. They include "gold, platinum, silver, lead, copper, nickel, zinc, tin, manganese, iron, phosphorus stones (phosphate rock ?), precious stones, sulphur, salt, petroleum, natural gas, and all other things of similar character." To the Government belong also "all precious stones, gold, platinum, manganese, and other metals that are found lying on the earth," as well as, of course, all mineral substances found on State land that are mentioned in the following paragraph as being the rightful possession of the owner of the land.

To the landowner belong mineral waters, building stone, limestone, cement rock, road materials, as well as clays and yellow earth for paint, salt made by evaporation, and in general all mineral deposits that are found on the surface of the earth or above bedrock, except those classified as State-owned mineral substances. (Art. 2 and 3.)

Although the provisions of the mining law shall not be construed to prevent the Government from permitting the use of public lands in accordance with the law relating thereto or from granting public lands for agricultural

and other purposes, no rights are to be understood to be granted that are contrary to the Government's mineral ownership rights. (Art. 4.)

Article 24 reads as follows:

> In consideration of the importance of the mining industry to the development of the Republic, the mining operations provided for and permitted by this law are hereby declared to be of public utility and as justifying the power of eminent domain hereby provided to be exercised against private property and for those further special rights the exercise of which is provided for in this law. . . .

Any mining right or claim becoming void by the operation of the mining law shall be construed to be public property and subject to be granted anew. (Art. 38.)

MINING PRIVILEGES IN GENERAL

In addition to the obvious right to exploit State-claimed minerals, the Government may exploit on property of the Republic those minerals that are classified as belonging to the private owner of land or may give the right to a private person, who shall be under contract with the Secretary of the Treasury to protect the rights of the Republic. (Art. 4.)

A landowner, without obtaining a mining privilege from the Government, may exploit on his own land the minerals that fall under the classification of privately owned minerals. (Art. 3.) With this exception and the exception of the right of natives or citizens to wash the gold-bearing sands in rivers and other waters (according to custom), no person may legally explore for or exploit minerals unless he is the owner of (art. 5 and 6):

1. A valid mining concession, or mining right, obtained with the authority of the mining law.

2. A valid license to explore.[5]

3. A valid permission to prospect.[6]

4. A valid mining claim.

It is not necessary that a prospecting permit precede an exploring license or that either precede the granting of a mining concession. (Art. 7.)

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5 "A license or permission to explore or prospect gives permission to do only such work as may be necessary to carry to completion the exploration or location work of a mine."

6 Ibid.

EXPLORING LICENSE

"Any person" complying with the legal requirements may obtain an exploring license, which is an exclusive right to the extent that during its existence no mining claim and no mining concession may be granted for the land in question. This provision does not prevent the license holder himself from filing a mining claim or from being granted a mining concession. (Art. 8.) A licensee, however, must seek from the owner permission to explore his land--a permission which may not be withheld except upon the question of damages. Should the owner refuse, the license holder shall file with the Secretary of the Treasury a petition, setting forth the facts in the case. The Secretary shall summon the landowner to a hearing to be held within 60 days of the date of the petition and shall assess actual damages for loss or destruction of goods or property or (if such sum can not then be determined) may order the filing of a bond in a penal sum sufficient to cover the damage. An appeal from the decision of the Secretary (in the nature of a bill in equity, to be heard before a jury) may be taken to the circuit court. (Art. 9.)

Area.--A license to explore may not cover more than 250 square miles in one block. (Art. 8.)

Duration.--An exploring license, issued for one year, may be renewed for one additional year but may not be renewed by the same person thereafter on the same piece of land for a period of three years. (Art. 8.)

Fees.--The fee for each license and for each renewal thereof is $200, payable in revenue stamps. (Art. 8 and 11.)

Registration.--The Secretary of the Treasury shall by regulations provide for the registration of papers, documents, etc., that may be necessary and shall provide for proper fees for the entry and registration of all documents, maps, grants, etc., the fees to be paid in revenue stamps. (Art. 11.)

TUNNEL SITES

A tunnel site, which is in the nature of an exploring license, is issued for the development of veins or exploration work. It differs from the exploration license in that the site must be accurately described and must not exceed 100 meters in depth or length by the actual width of the tunnel.

Application.--An application for a tunnel site, which is made by special petition through the Secretary of the Treasury, must include a request for a dump area for the material to be removed from the tunnel. The dump area must be shown on a map in its relation to all natural objects and water courses in the immediate vicinity.

Demarcation.--The site, when granted, must be marked on the surface of the ground by actual survey (precision of 1:10,000) with stakes on the surface along the center line, the stakes to be not more than 100 meters apart and to be intervisible. (Art. 26.)

Special rights.--In addition to the rights granted to exploring licensees, owners of tunnel sites shall have the right to apply for a mining concession for all veins or lodes, within 1,000 meters from the "points where the tunnel first enters cover on the center line of the tunnel, providing such vein was not previously known to exist, discovered in such tunnels to the same extent as if discovered from the surface of the earth. Location on the line of such tunnels, of veins or lodes not appearing on the surface, made by other parties after commencement of the tunnel and while the same is being prosecuted with reasonable diligence, shall not be valid." (Art. 27.)

Abandonment.--A 6-month failure to develop a tunnel shall constitute abandonment of the right to all undiscovered veins along the line of the tunnel. (Art. 28.)

MINING RIGHT OR CONCESSION

General.--"Any person may make application to the Government through the Secretary of the Treasury for a mining privilege, provided such person be a citizen of the Republic, or provided, in case he is not a citizen, that his application must be approved in the same way as a concession for railroads and other public utilities must be presented to and approved by the Legislature." (Art. 12.) This provision seems to exempt natives from the necessity of having their applications approved by the Legislature. However, article 24 reads:

> Mining rights or concessions will be granted by the Legislature to any person who is first entitled thereto and after complying with the provisions of this act.

Application procedure.--Application for a concession must be in the form prescribed by the Secretary of the Treasury. It shall include the name and address of the person making the petition (in the case of a foreigner, his home address also, confirmed in the consulate of his country). It shall state the purpose of the mining right, the kind of mineral or metal to be mined, the date of discovery, and the name of the discoverer. It shall be accompanied by an accurate survey (precision not less than 1:10,000) and a map showing the geographic position of the claim with respect to adjacent natural landmarks and political boundaries. Should there be any permanently marked Government survey station located within 10 kilometers of the proposed mining concession or privilege, the station is to be connected with the points shown on the map, and its direction and distance are to be designated. "Nothing herein shall be deemed to deprive any person holding a license to explore or who has filed notice of claim from the right to work his mining claim in accordance with the provisions of the law." (Art. 12.) (See section of this paper entitled "Mining Claims".)

Classes of mining concessions.--Mining concessions (as well as mining claims) are divided with respect to the mineral substances involved, the size of the area, and the mode of petition to be used. (Art. 13 to 17.)

1. The first class covers oil, coal, and gas, or asphalts. The "claim" (unit) shall not exceed 1,000 meters by 1,000 meters, measured horizontally. One person may hold any number of units. Application shall be made as indicated in the preceding paragraph.

2. The second class covers lode claims, which shall comprise metal mines, including gold, tin, and other minerals not in placers or bedded deposits. The unit shall not exceed 500 square meters; and one person shall not have more than five units. All angles must be right angles. Two sides must be as nearly as possible parallel to the general course of the vein. The application, in addition to following the general requirements, must prove:

(1) The existence of a lode or vein on the property in question.

(2) The posting of a notice (as hereinafter provided), if a claim has been filed.

(3) The sinking of a discovery shaft.

(4) The marking of the boundaries of the claim by monuments of stones or concrete, which shall not be less than one and one-half meters in height, and which shall be placed at the corner or angles of the claim.

(5) The making and filing of the location certificate, as hereinafter specified, in the office of the Treasury, if a claim has been filed.

3. The third class covers placer claims, which shall consist of auriferous gravels or any other material bearing gold, platinum, tin, or other precious minerals or gems. The unit shall not exceed 100 square meters; and no person shall possess more than 100 hectares. Application shall be made as in class 2.

4. The fourth class covers bedded deposits commonly known as blanket veins, such as ore-bearing beds or iron, zinc, phosphates, or other minerals that occur as nearly flat or stratified deposits, as distinguished from apex or lode veins or outcrops. The unit shall not exceed 1,000 square meters; and no person shall own more than five units. Application shall be made as in class 2.

Minerals covered.--If in the course of mining operations a mine owner, or concessionaire, discovers in his mine another metal or mineral of the same class as that for which he made application, he may mine it without filing additional papers. But if the new ore or mineral is not included in the classification under which his mining right was granted, he must apply to the Government for an amendment of his right, to cover the new conditions.

MINING CLAIMS

By staking claims, the owner in fee of land, or of an exploring license, or of a prospecting permit may acquire the right to exploit "the mineral, metal, or chemical deposits" that are the property of the Liberian Government. (Art. 19.)

Staking and filing of claim.--The person desiring to locate a claim must (after discovery of minerals) drive a post or monument at each corner or angle of the claim and must on the most conspicuous spot of the claimed land post a notice in the form prescribed (see succeeding paragraph). If the claim is in the hinterland (interior), a copy of the notice shall be filed with the district commissioner, who shall immediately forward a copy to the Secretary of the Treasury, with a memorandum of the date and the time of filing. If the claim is located in one of the counties, the claimant shall post a copy of the claim in the office of the county superintendent, who shall indorse on the claimant's copy the time and the date of filing and shall send a copy to the Secretary of the Treasury, with a memorandum of the date and the time of filing. Refusal or neglect to file on the part of any official shall not prejudice the claimant's rights, and the defaulting official shall be liable to a fine of $50. The claimant shall post in or send to the office of the Secretary, for filing, a copy of the notice, upon which shall be noted the time and the date of filing in the district or county office, as the case may be. (Art. 19.)

Form of notice.--The form of the notice to be posted and filed shall be as follows (art. 20):

> REPUBLIC OF LIBERIA COUNTY OR DISTRICT OF __________ Know all men by these presents that I __________, the undersigned, have this _____ day of _______, 1934, located and claimed and by these presents do locate and claim, by right of discovery and location, in compliance with the mining law of Liberia and in accordance with the regulations issued thereon, a claim of the _____ class (insert kind of claim as provided for in the law) and that the same claim is hereby described in accordance with the law as follows: This claim is located at __________, on property belonging to (insert the name of the owner, if known). The mineral that has been discovered by me is _____; said mineral deposit was discovered on the ____ day of _____, 1934.

Claimant ____________________
Address ____________________

(If a foreigner, home address and passport number to be inserted.)
Filed at the County Superintendent's office on ____________, at the hour of ____________ on ________________, 1924.

Or

Filed at the District Commissioner's office, ____________ District, at the hour of ______________ on ________________, 1924.

Area.--The size of the area that may be staked shall be governed by the classification and regulations set forth under the discussion (in this paper) of "Mining Right or Concession." (Art. 19 and 13 to 17.)

Duration.--The holder of a mining claim is entitled to operate and develop for a period of two years from the date of discovery and may then apply for a permanent right or concession. (Art. 19 and 21.)

Filing fee.--Before a claim is allowed and recorded in the office of the Secretary, the claimant shall pay a fee of $10, in revenue stamps. He shall pay also a fee of $1 to the county superintendent or to the district commissioner, as the case may be. (Art. 19.)

Minerals covered.--A claim holder (in distinction from the holder of a mining right) that during his operations discovers another mineral of the same class as the one he applied for must file a separate discovery and claim notice of each mineral alleged to have been discovered and intended to be mined. (Art. 23.) (Presumably, this provision applies to minerals of a different class also.)

Work required.--A claim holder shall be entitled to operate and develop his claim for two years from the date of discovery, provided:

> That such person produces proof in the office of the Secretary of the Treasury on or before one year from the date of said discovery that he has done not less than $100 (gold) worth of development work on the said mine claim and continues so to do annually and that within two years from date of said discovery or at the next session of the Legislature thereafter ensuing he makes application through the Secretary of the Treasury to the Legislature for the grant of a permanent mining right, or concession. (Art. 21.)

The work required to hold a mining claim must be expended for the making or driving of shafts, tunnels, excavations, etc., or for the development of the vein, lode, or strata of the mineral and may not be expended for buildings, machinery, road work, etc. (Art. 22.)

MILL SITES

A mill site will be granted upon public lands only in connection with a mine in actual and continuous operation (the mine not to be shut down for a period of more than six months).

Application.--An application for a mill site, made through the Secretary of the Treasury, must be accompanied by a sworn statement as to the necessity for the mill, a description thereof, an estimate of the cost, and a pledge that work will be commenced within one year from the date of the permit. Failure to commence and carry out the work within one year from the date of the permit shall render the application void.

Fee.--The fee shall be only a nominal filing fee. (Art. 28.)

EXTRALATERAL RIGHTS AND EASEMENTS

Evidently, the law of apex holds, though the phraseology is somewhat confused. Article 30 reads as follows:

> Any person holding a mining concession by virtue of this act may have the right to follow a vein under adjacent property within the end lines of his claim, but is expressly prohibited from following the vein beyond the side lines of his claim.

Article 37 reads as follows:

> A mining right conveys the right to follow a vein on its dip to any depth for any distance between the vertical plains of the end lines. . . .

Article 37 says also that should the holder of a mining right find it necessary to pass under any building, road, bridge, railway, or other public works, he must first obtain permission from the Secretary of the Treasury, and he shall be liable for any damage resulting from his operation.

Article 35 provides that mining rights, or concessions, shall not carry with them permission to operate a railroad on other than the mining site from the pit, mine opening, placer workings, etc., to the mill or to operate telephone, telegraph, water system, hydraulic electric system, or any other public utility beyond the confines of the mining and milling sites.

Article 36 provides that a mining concession shall not carry any agricultural, timber, or other surface rights, except in connection with:

1. Habitations, office buildings, mill buildings, engine houses, storehouses, etc.

2. Dumps, ditches for drainage, roads within the surface boundaries of the claim.

3. Trenches, open cuts, etc., constructed for and necessary to mining operations.

Timber cut to clear areas for buildings and the works enumerated or to be used for construction upon the claim shall not be sold.

SPECIAL RULES GOVERNING PETROLEUM AND NATURAL GAS

Any one finding or claiming discovery of petroleum or natural gas must report to the Secretary of the Treasury before opening a well, in order that ignorance or incompetence in the handling of the deposit may not cause loss to the Government.

The Secretary of the Treasury is authorized to order the employment of a competent graduate geologist and to promulgate all other regulations to the best interest of the Republic in the operation, maintenance, and exploitation of petroleum wells and deposits. (Art. 31.)

ROYALTY

The amount of royalty to be paid to the Government under mining rights, or concessions, shall be determined by contracts to be entered into. In no case shall the Government demand more than 15 per cent of the value of the product mined, as calculated at the mine shaft. (Art. 24.)

FINES AND FORFEITURE

Fines for the violation of any provisions of the mining law shall not be less than $5 nor more than $50 for each violation. Fines are imposed by the Secretary of the Treasury, from whose decision appeal may be taken to the circuit court, to be heard without jury. (Art. 34.)

The cancellation of any privilege, license, permit, or concession shall result from falsification in any material statement in any affidavit provided for by the mining act. (Art. 29)

All mining rights, concessions, or claims shall be held to be forfeited unless before the first day of January of each and every year proof is filed in the office of the Secretary of the Treasury that during the preceding year development work or operation to the value of $100 (gold) has been done on each and every claim owned by any person. (Art. 18.)

MISCELLANEOUS

The Secretary of the Treasury is given authority to order an inspection of any mining premises or claims and to order topographical maps and underground maps to be filed at any time to the extent of one in six months. He has the right to regulate the books, reports, and records that shall be kept, which shall always be subject to inspection by the Government. (Art. 33.)

All maps directed by the mining act to be filed shall be sworn to by a competent surveyor, who in his affidavit must state his training and competence. (Art. 29.)

Remedy in the case of any survey or boundary dispute shall be sought through application to the Secretary of the Treasury, who shall, upon the deposit of the estimated cost, order a survey. The person at fault shall pay the costs, which in default of payment may be recovered in an ex parte proceeding before a circuit court. If the petitioning party is in the right, only the excess of the deposit made by him shall be refunded, the petitioner having the right by ex parte action to recover the balance. (Art. 33.)

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Department of Commerce

UNITED STATES BUREAU OF MINES
Scott Turner, Director

INFORMATION CIRCULAR

MINING LAWS OF DENMARK AND DANISH POSSESSIONS

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DEPARTMENT OF COMMERCE--BUREAU OF MINES

MINING LAWS OF DENMARK AND DANISH POSSESSIONS[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper presents one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the rights of American citizens to explore for minerals and to own and operate mines in various foreign countries. This interpretation of the laws of Denmark and her possessions, has been prepared entirely from answers made by Ernest L. Ives, American charge d'affaires, Copenhagen, to a questionnaire initiated by the United States Bureau of Mines and transmitted through the courtesy of the Department of State.

INTRODUCTION

Denmark.- Denmark has no specific mining code, probably because all the economic mineral occurrences in that country are surface deposits, chiefly limestone, granite, clay, and peat.

Greenland[3].- Greenland, now Denmark's only colonial possession, which is under the Royal Greenland Administration in Copenhagen, also has no special mining laws. Beyond a small coal mine operated by the Danish Government and a large cryolite mine operated by a private Danish mining company, Greenland has practically no mining industry.

Greenland is a "closed country," and no one, not even a Dane, is permitted to enter it without special permission from the Danish Government.[4] The Government does not permit the employment of natives in the mines; so all labor for mining is imported from Denmark. Nevertheless, the Danish Government is

1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6631."
2 Rare metals and nonmetals division, U. S. Bureau of Mines.
3 Brief summaries of the mineral resources of Iceland and Greenland are given in a supplement to this circular.
4 Gordon, Samuel G., Mining Cryolite in Greenland: Eng. and Min. Jour.-Press, vol. 121, No. 6, Feb. 6, 1926, pp. 236-240.

paternally inclined, Greenland being largely supported by the royalties from cryolite.

Iceland.[5] - Iceland, which since December 1, 1918, has been acknowledged to be a sovereign State, united with Denmark through little more than the identity of the Danish ruler, has its own mining code, dated July 30, 1909, supplemented by law No. 8, of May 31, 1927. In addition to this general mining law, the Icelandic Alting in 1922 and 1931 passed legislation governing the production and exportation of calcareous spar (see section of this paper entitled "Special Spar Legislation").

RIGHTS OF FOREIGNERS

A foreigner is permitted by the mining law to explore for minerals and to own and operate mines in Iceland upon equal terms with nationals, on condition that he appoint a duly authorized agent in Iceland to represent him and submit the agent's name to the mining authority in writing when making application for a prospecting license. However, prospecting permits are issued by the mining authority (the Chief of Police) only to persons known personally to him or persons whose identity can be vouched for by two well-known citizens of Iceland. Actual discovery of metal or ore automatically confers the right to a mining concession.

PROSPECTING

A prospecting permit, which is issued for two years, under the jurisdiction of the Chief of Police, does not confer an exclusive prospecting privilege, nor does it require that a certain amount of work be done to keep it in force. Any one placing obstacles in the way of the holder of a legally authorized prospecting permit is subject to a fine of 5 to 50 crowns.[6]

The law gives authority for the "search of metals and ore on commons, in deserts, on mountain pastures, on certain feudal estates, and on Government property." "Prospecting for metal and ore is not permitted on fields or soil under cultivation or within 150 meters (200 meters in case explosives are employed) of dwellings, barns, bridges, and like structures, without the consent of the owner of the surface land." A prospector shall either make a deposit (not exceeding 200 crowns) as a guarantee for the payment of any damage he may cause or agree in writing (the agreement to be included in the permit) not to uproot or dig in gardens or fields.

A prospector must report to the landowner, in the presence of witnesses, the finding of "metal," within eight weeks of its discovery.

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5 See footnote 3.

6 The average exchange value for 1930 of the Danish crown was 26.765 cents (26.8 cents at par).

MINING

A successful prospector desiring to mine shall--

1. Make a verified report (in duplicate), concerning the metal or ore discovered, to the Chief of Police.

2. Submit, within two years from the registration of the discovery, to the same authority a written application for a mining concession, which shall not be refused.

The holder of a mining right may request the laying out of a mining area, which must be done within six months from the date of the application for a concession. The staking out of a claim, under these regulations, gives the concessionaire exclusive right to mine therein.

The original discoverer of mineral has the right to request two mining areas. A permit may cover 100,000 square meters. If the mineral is found in layers, the area must be staked in the form of a square ("equilateral rectangular square"); if it occurs in one or more veins, the permit holder may decide the proportion of the length to the width (the width not to be less than 100 meters, however) and the direction in which the mine shall be laid out. Extralateral rights are not granted, subsoil boundaries being fixed by lines extending vertically downward.

FEES

The law authorizes the following fees:

1. Prospecting permit, 2 crowns.

2. Mining permit, 25 crowns.

3. Cost of staking out a mining area, 40 crowns.

4. Rental to be paid annually to the National Treasury or to the Feudal Church, 50 crowns.

5. Rental to be paid annually to the landowner, 10 crowns, plus 5 öre[7] a square meter of land on which buildings are erected.

In addition, the holder of prospecting or mining rights shall pay to the Chief of Police his traveling expenses and an honorarium.

SPECIAL SPAR LEGISLATION

The law of 1922 governing the mining production and exportation of calcareous spar declares that the Icelandic Government shall have the sole right

7 A Danish coin worth 0.01 of a crown.

to export this product. The regulations of November 22, 1931, decree that all landowners, lease holders, or concessionaires shall have the right of digging calcareous spar within their own territory. However, all persons so engaged must report the operations of each separate mine to the Government. All producers of Iceland spar (individuals or companies) are liable to the Government for all expenses connected with the export of their product and for a fee of 2 per cent upon the value of the exported product.

SUPPLEMENT

MINERALS OF ICELAND AND GREENLAND

Iceland

There are no mines in Iceland worth mentioning except calcareous spar, of a superior quality of calcite, called Iceland spar. Sulphur, iron ore, copper pyrite, lignite, and peat have been mined at different times. There has been talk of working iron, copper, and gold mines, but this has so far come to nothing.[8] Traces of gold and silver were found near Reykjavik as early as 1907, when an unsuccessful attempt was made to exploit them. Rumors have been to the effect that gold occurs in large areas in the eastern part of Iceland.[9] Also platinum, iridium, rhodium, quicksilver, copper, antimony, arsenic, cadmium, tellurium, lead, iron, and bismuth have been reported, but definite data concerning them are not available.

Since the war, only lignite, peat, and spar have been produced.[10]

Lignite (discovered in 1900 at Nordfjord and in 1906 at Borgarfjord) was produced in 1917, 1918, and 1919, as follows: 1,980 metric tons, valued at 297,000 crowns; 2,350 metric tons, valued at 423,000 crowns; and 390 metric tons, valued at 65,300 crowns. An attempt to use it locally as fuel failed.

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8 Thorsteinsson, Thorsteinn, Director of Statistics for Iceland, ________: Handbook of Iceland, Reykjavik, 1930, pp. 9-10.

9 Dodge, H. Percival, Gold--Iceland: Consular Rept. 310980, Copenhagen, June 3, 1929.

10 Eiriksson, H. H., Director of Mining Operations in Iceland.

Production of peat from 1922 to 1928 is as follows:

Year	Quantity, metric tons	Value, crowns
1922	30,223	906,690
1923	-------	--------
1924	1/25,000	1,500,000
1925	18,737	300,000
1926	(2)	(2)
1927	22,000	880,000
1928	17,094	750,000

1 Approximate.
2 Statistics not available.

A rich deposit of spar occurs at Akar, in Faxe Bay, and a quarry of spar occurs near Eskifiord, on the east coast of the island. As early as 1899 the report was that small quantities of spar of optical grade were being exported annually. Reports since the World War give the production of spar for the years 1921 to 1925, both inclusive, as follows:[11]

Year	Quantity, kilograms	Value, crowns
1921	600	10,000
1922	100	10,000
1923	1,750	50,000
1924	1,200	30,000
1925	520	30,000

Greenland

Shipments from the only mine of cryolite in the world, at Ivigtut, Greenland, have been increasing for several years, the total for 1930 being the largest on record. However, producers report large stocks on hand in Denmark and in the United States and a contemplated reduction in production. The exclusive importer in the United States for this product since 1865 has been the Pennsylvania Salt Manufacturing Co. (Philadelphia, Pa.); the importer in Denmark is the Øresunds Chemiske Fabriker (Copenhagen). The mine, which belongs to the Øresunds Chemiske Fabriker, is operated under a State concession by Aktieselskabet Kryolith-Mine-og Handelsselskabet, Copenhagen. The accompanying tabulation of cryolite shipments (1919-1930) shows the importance of the industry.

For a comprehensive description of the deposit in Greenland, its geology, mineralogy, and mining methods, see the article by Gordon.[12] Further

11 See footnote 8.
12 See footnote 4.

discussion of the deposits and production data may be found in the annual volumes of Mineral Industry. Its early history is described in the volume for 1893.[13]

Greenland produced 53,000 kilograms of graphite in 1924 and 3,600 metric tons of coal in 1929. In 1910 a deposit near Ivnatsiak was worked for copper ore, but no ore was exported. Other minerals, of at least geological interest, have been reported:[14] Asbestos, barytes, chrome ores, feldspar, fluorspar, gems, gold, iron, lead, mica, molybdenite, nickel, phosphate rock (apatite), rare earth minerals, talc, tantalite, tungsten, and zinc. A detailed report of the minerals in the vicinity of Ivigtut, Narsarsuk, Tunugdliarfik, and Kangerdluarsuk has been made by Gordon.[15]

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1 Roush, G. A., Minor Nonmetals; Cryolite: Min. Ind., 1930, vol. 39, McGraw-Hill Book Co. (Inc.), New York, 1931, p. 663.

13 Rothwell, R. P., Cryolite: Min. Ind., 1893, vol. 2, The Scientific Publishing Co., 1894, pp. 301-304.
14 Ball, Sydney H., Mineral Resources of Greenland, Meddelelser om Grønland, vol. 63, Copenhagen, 1922, pp. 1-60.
15 Gordon, Samuel G., Minerals Obtained in Greenland on the Second Academy-Vaux Expedition, 1923: Proc. Acad. Nat. Sci., Philadelphia, Pa., 1924, vol. 76, Philadelphia, 1925, pp. 249-268.

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June, 1932.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE--BUREAU OF MINES

MINING LAWS OF DENMARK AND DANISH POSSESSIONS[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper presents one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the rights of American citizens to explore for minerals and to own and operate mines in various foreign countries. This interpretation of the laws of Denmark and her possessions has been prepared entirely from answers made by Ernest L. Ives, American charge d'affaires, Copenhagen, to a questionnaire initiated by the United States Bureau of Mines and transmitted through the courtesy of the Department of State.

INTRODUCTION

Denmark.- Denmark has no specific mining code, probably because all the economic mineral occurrences in that country are surface deposits, chiefly limestone, granite, clay, and peat.

Greenland[3].- Greenland, now Denmark's only colonial possession, which is under the Royal Greenland Administration in Copenhagen, also has no special mining laws. Beyond a small coal mine operated by the Danish Government and a large cryolite mine operated by a private Danish mining company, Greenland has practically no mining industry.

Greenland is a "closed country," and no one, not even a Dane, is permitted to enter it without special permission from the Danish Government.[4] The Government does not permit the employment of natives in the mines; so all labor for mining is imported from Denmark. Nevertheless, the Danish Government is

1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6631."
2 Rare metals and nonmetals division, U. S. Bureau of Mines.
3 Brief summaries of the mineral resources of Iceland and Greenland are given in a supplement to this circular.
4 Gordon, Samuel G., Mining Cryolite in Greenland: Eng. and Min. Jour.-Press, vol. 121, No. 6, Feb. 6, 1926, pp. 236-240.

paternally inclined, Greenland being largely supported by the royalties from cryolite.

<u>Iceland</u>.[5] - Iceland, which since December 1, 1918, has been acknowledged to be a sovereign State, united with Denmark through little more than the identity of the Danish ruler, has its own mining code, dated July 30, 1909, supplemented by law No. 8, of May 31, 1927. In addition to this general mining law, the Icelandic Alting in 1922 and 1931 passed legislation governing the production and exportation of calcareous spar (see section of this paper entitled "Special Spar Legislation").

RIGHTS OF FOREIGNERS

A foreigner is permitted by the mining law to explore for minerals and to own and operate mines in Iceland upon equal terms with nationals, on condition that he appoint a duly authorized agent in Iceland to represent him and submit the agent's name to the mining authority in writing when making application for a prospecting license. However, prospecting permits are issued by the mining authority (the Chief of Police) only to persons known personally to him or persons whose identity can be vouched for by two well-known citizens of Iceland. Actual discovery of metal or ore automatically confers the right to a mining concession.

PROSPECTING

A prospecting permit, which is issued for two years, under the jurisdiction of the Chief of Police, does not confer an exclusive prospecting privilege, nor does it require that a certain amount of work be done to keep it in force. Any one placing obstacles in the way of the holder of a legally authorized prospecting permit is subject to a fine of 5 to 50 crowns.[6]

The law gives authority for the "search of metals and ore on commons, in deserts, on mountain pastures, on certain feudal estates, and on Government property." "Prospecting for metal and ore is not permitted on fields or soil under cultivation or within 100 meters (200 meters in case explosives are employed) of dwellings, barns, bridges, and like structures, without the consent of the owner of the surface land." A prospector shall either make a deposit (not exceeding 200 crowns) as a guarantee for the payment of any damage he may cause or agree in writing (the agreement to be included in the permit) not to uproot or dig in gardens or fields.

A prospector must report to the landowner, in the presence of witnesses, the finding of "metal," within eight weeks of its discovery.

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5 See footnote 3.

6 The average exchange value for 1930 of the Danish crown was 26.765 cents (26.8 cents at par).

MINING

A successful prospector desiring to mine shall--

1. Make a verified report (in duplicate), concerning the metal or ore discovered, to the Chief of Police.

2. Submit, within two years from the registration of the discovery, to the same authority a written application for a mining concession, which shall not be refused.

The holder of a mining right may request the laying out of a mining area, which must be done within six months from the date of the application for a concession. The staking out of a claim, under these regulations, gives the concessionaire exclusive right to mine therein.

The original discoverer of mineral has the right to request two mining areas. A permit may cover 100,000 square meters. If the mineral is found in layers, the area must be staked in the form of a square ("equilateral rectangular square"); if it occurs in one or more veins, the permit holder may decide the proportion of the length to the width (the width not to be less than 100 meters, however) and the direction in which the mine shall be laid out. Extralateral rights are not granted, subsoil boundaries being fixed by lines extending vertically downward.

FEES

The law authorizes the following fees:

1. Prospecting permit, 2 crowns.

2. Mining permit, 25 crowns.

3. Cost of staking out a mining area, 40 crowns.

4. Rental to be paid annually to the National Treasury or to the Feudal Churdh, 50 crowns.

5. Rental to be paid annually to the landowner, 10 crowns, plus 5 öre[7] a square meter of land on which buildings are erected.

In addition, the holder of prospecting or mining rights shall pay to the Chief of Police his traveling expenses and an honorarium.

SPECIAL SPAR LEGISLATION

The law of 1922 governing the mining production and exportation of calcareous spar declares that the Icelandic Government shall have the sole right

7 A Danish coin worth 0.01 of a crown.

to export this product. The regulations of November 22, 1931, decree that all landowners, lease holders, or concessionaires shall have the right of digging calcareous spar within their own territory. However, all persons so engaged must report the operations of each separate mine to the Government. All producers of Iceland spar (individuals or companies) are liable to the Government for all expenses connected with the export of their product and for a fee of 2 per cent upon the value of the exported product.

SUPPLEMENT

MINERALS OF ICELAND AND GREENLAND

Iceland

There are no mines in Iceland worth mentioning except calcareous spar, of a superior quality of calcite, called Iceland spar. Sulphur, iron ore, copper pyrite, lignite, and peat have been mined at different times. There has been talk of working iron, copper, and gold mines, but this has so far come to nothing.[8] Traces of gold and silver were found near Reykjavik as early as 1907, when an unsuccessful attempt was made to exploit them. Rumors have been to the effect that gold occurs in large areas in the eastern part of Iceland.[9] Also platinum, iridium, rhodium, quicksilver, copper, antimony, arsenic, cadmium, tellurium, lead, iron, and bismuth have been reported, but definite data concerning them are not available.

Since the war, only lignite, peat, and spar have been produced.[10]

Lignite (discovered in 1900 at Nordfjord and in 1906 at Borgarfjord) was produced in 1917, 1918, and 1919, as follows: 1,980 metric tons, valued at 297,000 crowns; 2,350 metric tons, valued at 423,000 crowns; and 390 metric tons, valued at 66,300 crowns. An attempt to use it locally as fuel failed.

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8 Thorsteinsson, Thorsteinn, Director of Statistics for Iceland, _________: Handbook of Iceland, Reykjavik, 1930, pp. 9-10.

9 Dodge, H. Percival, Gold--Iceland: Consular Rept. 310980, Copenhagen, June 3, 1929.

10 Eiriksson, H. H., Director of Mining Operations in Iceland.

Production of peat from 1922 to 1928 is as follows:

Year	Quantity, metric tons	Value, crowns
1922	30,223	906,690
1923	------	-------
1924	1/25,000	1,500,000
1925	18,737	300,000
1926	(2)	(2)
1927	22,000	880,000
1928	17,094	750,000

1 Approximate.
2 Statistics not available.

A rich deposit of spar occurs at Akar, in Faxe Bay, and a quarry of spar occurs near Eskifiord, on the east coast of the island. As early as 1899 the report was that small quantities of spar of optical grade were being exported annually. Reports since the World War give the production of spar for the years 1921 to 1925, both inclusive, as follows:[11]

Year	Quantity, kilograms	Value, crowns
1921	600	10,000
1922	100	10,000
1923	1,750	50,000
1924	1,200	30,000
1925	520	30,000

Greenland

Shipments from the only mine of cryolite in the world, at Ivigtut, Greenland, have been increasing for several years, the total for 1930 being the largest on record. However, producers report large stocks on hand in Denmark and in the United States and a contemplated reduction in production. The exclusive importer in the United States for this product since 1865 has been the Pennsylvania Salt Manufacturing Co. (Philadelphia, Pa.); the importer in Denmark is the Øresunds Chemiske Fabriker (Copenhagen). The mine, which belongs to the Øresunds Chemiske Fabriker, is operated under a State concession by Aktieselskabet Kryolith-Mine-og Handelsselskabet, Copenhagen. The accompanying tabulation of cryolite shipments (1919-1930) shows the importance of the industry.

For a comprehensive description of the deposit in Greenland, its geology, mineralogy, and mining methods, see the article by Gordon.[12] Further

11 See footnote 8.
12 See footnote 4.

discussion of the deposits and production data may be found in the annual volumes of Mineral Industry. Its early history is described in the volume for 1893.[13]

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June, 1932

Department of Commerce

UNITED STATES BUREAU OF MINES
Scott Turner, Director

INFORMATION CIRCULAR

MINING LAWS OF HAITI

BY

E. P. Youngman

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

MINING LAWS OF HAITI[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper is one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the right of American citizens to explore for minerals and to own and operate mines in various foreign countries. This interpretation of the mining law of Haiti, prepared from an English translation of the law now in force in the Republic,[3] is published in lieu of the Bureau of Mines Information Circular 6304,[4] upon the same subject, but based upon a law that has recently been repealed.

INTRODUCTION

By a decree of March 14, 1929,[5] the President of the Haitian Republic, considering it to be necessary, until the mining legislation of the Republic shall have been revised, to put into effect the mining law of December 4, 1860 (relative to mines, diggings, and quarries), by the authority given in article 55 of the Constitution, declared the law of February 14, 1919, to be abrogated and the provisions of the earlier mining law (December 4, 1860) again to be valid. No concessions were granted under the law of 1919. All citations in this paper, unless otherwise designated, refer to the law of 1860.

1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6632."
2 Rare metals and nonmetals division, U. S. Bureau of Mines.
3 Monthly Bulletin of the International Bureau of the American Republics, Haiti; Mining Law: Vol. 12, No. 6, Washington, D. C., June, 1902, pp. 1449-1455.
4 Garman, A. D., Mining Laws of Haiti: Information Circular 6340, U. S. Bureau of Mines, Sept., 1930, 5 pp.
5 Passed by the Haitian Council of State, Mar. 16, 1929, and published in Le Moniteur de Haiti, Mar. 18, 1929.

RIGHTS OF FOREIGNERS

Article 19 of the law of 1860 includes foreigners among those entitled to obtain mining rights in Haiti. It reads as follows:

> Foreigners, as well as Haitians, whether as individuals or companies, may make bids and obtain concessions for the exploitation of mines or quarries.

Article 52 reads as follows:

> When land is necessary for exploitation and the concessionaire is a foreigner, the State shall acquire the same, but the value shall be paid by the concessionaire, to whom at the termination of the exploitation the amount of the resale shall be charged.

The foregoing provisions may be modified, however, under the Constitution. According to Garman[6]:

> By the Constitution of 1918 and the regulatory law of July 16, 1920, aliens who have resided in Haiti at least three months and complied with certain formalities are granted the right to own real property there solely for residential purposes and the needs of their agricultural, commercial, industrial, and educational enterprises, and not for the purpose of leasing or reselling it. This applies to individuals as well as to associations, other than stock companies. In the case of these latter, authorization must be obtained from the President of the Republic. But if a majority of the board of directors is of Haitian nationality, with the same privileges and responsibilities as belong to the foreign members, and the company is formed under the laws of Haiti and has its head office and principal establishment therein, the company is regarded as native and not subject to the above restrictions.
>
> On leaving the country, or on dissolution of the company, the foreign owner of real property is obliged to sell it within five years; otherwise, it will be sold at public auction, and only the net proceeds will be turned over to him.
>
> In case of the decease of a foreign property-owner, his heirs come into possession of the property and can continue holding it, provided they conform to the original requirements for obtaining it. Otherwise it is sold at auction.

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6 See footnote 4.

MINING AUTHORITIES

Article 12 of the law of 1860 provides that mine management shall be under the Department of the Interior, in a special branch to be organized. However, the law of March 14, 1929 (which abrogated the law of February 14 and restored the law of December 4, 1860), specifically charges the Minister of Public Works with the administration of all laws relating to mining and minerals.[7] Further, it is true that any provision of the 1860 law that is contrary to laws passed subsequently to the adoption of the Constitution of 1918 is invalid, by the terms of article 127.

Article 57 authorizes the administration and the police to inspect mines and quarries, under regulations to be adopted.

CLASSIFICATION OF MINERALS

The Haitian law, following French precedent, divides all minerals and fossil substances into three groups: Mines, "minieres," and quarries. (Art. 1-4.)

1. The term "mines" includes all those substances found in veins, strata, or deposits, either within the interior or upon the surface of the earth, as for example, gold, silver, platinum, mercury, lead, iron, copper, tin, zinc, calamine, bismuth, cobalt, antimony, molybdenum, tungsten, nickel, chromium, or other metallic substances; arsenic, tellurium, iodine, sulphur, plumbago, coal, petrified wood, bituminous substances, alum, sulphates having metallic bases, rock salt, and other similar substances.

2. The term "minières" includes all those iron ores denominated "alluvium," pyritic earths that may be converted into sulphate of iron, aluminous earth, peat, and other substances of the same class and origin.

3. The term "quarries" includes slate, filtering stones, construction and other rocks, marble, granite, limestone, gypsum, pozzolana, hydraulic clays, basalt, lavas, marl and chalkstone, sands, flint, clay, kaolin, galactine, potter's clay, earthy substances, pebbles of all kinds, and pyritic earths used as fertilizers.

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7 Heath, Donald R., Department in Charge of Mining in Haiti: Consular Dispatch 110, Port-au-Prince, Nov. 18, 1931

The State reserves to itself all substances classed as "mines" and all those classed as "quarries" that require subterranean tunnels for their exploitation. (Art. 5.)

Substances classed as "quarries" that may be exploited on the surface and those classed as "minieres" belong to the owner of the land. (Art. 6.)

Mineral Substances Belonging to the State

Mines and subterranean quarries are not subject to prescription, and they shall be exploited only under a concession granted by the State (Council of Ministers).

The mines and quarries themselves, together with the "buildings, machinery, shafts, tunnels, and other permanent works, the animals used in the interior of the works, and the instruments, tools, and utensils employed in exploitation" are considered to be real estate and are subject to the provisions of articles 247 and 428 of the Civil Code. The products of the mines and quarries, as well as other movable objects not included in the foregoing provision, are real property. (Art. 8-11.)

Mineral Substances Belonging to the Owner of the Surface

The owner of land containing surface-ore deposits (minières) and surface quarries, desiring either in person or through another to extract the minerals recognized by law as belonging to him, needs but to declare his intention so to do before the Department of the Interior, which must concede an authorization within six months from the date of the declaration.

Operations under such an authorization shall be confined within designated limits and shall be subject to Government inspection, to police regulation, and, in general, to all provisions of the law affecting the mining of State-owned minerals, in so far as they are applicable. (Art. 7 and 54-56.)

EXPLORATION

The right to prospect, or investigate--including not only the search for minerals but also exploration designed to demonstrate the possibility of profitable exploitation--must be obtained from the owner of the land or, in case of his refusal, from the State. Permission by the Government shall not be given until the owner of the land has been heard and a satisfactory compensation has been determined upon. (Art. 13 and 15.)

The Government shall grant to a successful explorer (1) indemnity, including expenses, and (2) a "just reward." (Art. 14.)

EXPLOITATION

Steps Preliminary to the Acquiring of a Concession

A concession is generally granted to the person that makes the most favorable offer in response to the Government's bid (notice of the intended ceding of a mine or quarry). However, the Government may grant a concession, without previous advertisement, to a person having the necessary notice of the existence of a deposit. (Art. 16 and 18.)

Any person or company that has announced a desire to bid for a concession may examine or explore the subject of the proposed concession under an authorization from the Government. (Art. 17.) A bidder for a concession must prove technical and financial ability. (Art. 20.)

The Government allows one month's time, before granting a concession, for the presentation of counter claims by the owner of the land or by others. All claims and damages, which must be settled before a concession may be given, will be heard before the courts, if the executive power can not bring about a satisfactory agreement. (Art. 21 and 22.) (See section entitled "Indemnities.")

The Concession

The concession shall give to the concessionaire the exclusive right to exploit the land covered by the grant and the right to the products exploited, the provisions of the Civil Code to govern except where they have been annulled directly or indirectly by the present law. A concession granted for the mining of a mineral or fossil substance does not include deposits of other substances within the same boundaries, which may form the subject of other concessions. (Art. 26 and 31.)

Whenever a concession has been granted in favor of several persons (or of a company), they must prove that operations will be conducted under one management and that a representative (one of themselves or an outsider) has been designated to receive advices and notifications and act either as plaintiff or defendant before the Government. Each concessionaire must select a domicile, which shall be recorded in the concession. (Art. 29 and 30.)

Extent.--The decree granting a concession specifies the extent of its area, which shall be surveyed and marked, when possible, by "fixed corner stones on the surface and by vertical planes, which shall pass through these points into the interior of the earth to an indefinite depth." The decree must be accomplished by a map of the surface area. (Art. 24 and 25.) One concessionaire may hold a number of concessions, provided each one is actively exploited. (Art. 28.)

Duration.--A concession shall remain in force as long as the work of exploitation continues. (Art. 23.)

Forfeiture.--A concession may be annulled for (1) the nonexploitation of the conceded area, (2) the nonpayment at the designated time of the quotas established by law, or (3) failure to comply with the conditions of the concession. (Art. 42.)

TRANSFERS

No transfer of a concession, either in whole or in part, is legal without the consent of the Government. (Art. 27.)

In this connection, a comparatively recent transfer, which was reported in the official publication of the Haitian Government, Le Moniteur, of July 11, 1929, is of interest.

The contract, dated March 22, 1905, between Ex-Senator Edmond Roumain and the Secretary of State for the Department of Public Works, for the exploitation of mines of iron and of copper in the Terre-Neuve district, was transferred to the Compagnie Miniere de Terre Neuve, a company now controlled by American interests. The transfer was made by a presidential decree of July 2, 1929, which approved certain modifications in the statutes of the company, under article 75 of the Constitution and articles 29 to 37 and 40 and 45 of the Commercial Code of Haiti.

RIGHTS OF SURFACE OWNERS

The owner of land upon which rights have been granted to another must give his consent before either an explorer or a concessionaire may operate on the surface occupied by "factories, shops, or establishments, or by buildings, houses, or dwellings within a radius of 300 feet." Moreover, the owner must be furnished bond for the payment of damages and injuries (should occasion arise) in case works are carried underneath the aforementioned buildings and establishments. (Art. 35.) (See subsequent discussion of "Indemnities.")

A landowner that is compelled to forgo the profits of his property because of the mining privileges granted to another has a right to a part of the profits. (Art. 40.) (See section of this paper entitled "Rents or Royalties.")

Provisions with respect to the indemnity due to the owner of the surface are as follows (art. 34-35 and 48-51):

1. If the exploration or the exploitation is only preliminary (that is, does not exceed one year), and if the soil (after restoration) is capable of cultivation as before, the indemnity shall be double that which the land would have produced during the same period.

2. The amount of compensation shall constitute a security for the landowner's creditors, in the same manner as would a regular mortgage on the land occupied.

3. If the works of exploring or mining have deprived the owner of the use of his land for a period exceeding one year, or if the land has been rendered unsuitable for cultivation, the owner shall have the right to demand that his land be purchased.

4. If the occupation of the land has rendered it incapable of yielding the results "that correspond to it by nature," the owner thereof shall have the right to demand that it be expropriated. Expropriation of the land shall cancel all rights to indemnity on the part of the owner.

DAMAGE SUITS

The settlement of damages and all other indemnities, as well as expenses the refund of which is provided for in the present law, shall be referred to courts of justice (provided amicable adjustment can not be made), under the following stipulations (art. 33-47):

1. The courts, or tribunals, shall appoint experts and shall see that their acts conform to the provisions of the Civil Code of Procedure.

2. The experts shall be selected from persons experienced in mining subjects.

3. The Commissioner of the Government shall always be heard, and he shall make his report after the experts have rendered their decision.

4. The courts shall determine the compensation to be paid the experts, as well as other expenses occasioned by the examination, and may order the deposit of the required amount by the party soliciting the examination.

In questions of indemnity concerning the value of property, the Government and the landowners are the interested parties; in questions of compensation for alleged damages, the concessionaire and the claimant are the interested parties. (Art. 33.)

RENTS OR ROYALTIES

A concessionaire shall pay to the Government both a fixed rent, or royalty, and a proportional royalty upon the products of his operations. The State may remit, in whole or in part, the proportional royalty, in order to stimulate the mining industry, to compensate for the difficulties the work may offer, or to indemnify the operator in case of accident or other unforseen untoward circumstance. These quotas shall be kept as a special fund, the account of which shall be kept separately. (Art. 36-39.)

A royalty is due to the landowner that has been compelled "to forgo the profits of his property; this royalty, which shall never be less than 5 per cent of the proportional quota, the Government shall determine when deciding upon the State's share. (Art. 40-41.)

SUPPLEMENT

MINERAL INDUSTRY AND RESOURCES OF HAITI

The only mining activity of any importance in Haiti is that of the company previously mentioned under the section entitled "Transfers." The Compagnie Minière de Terre Neuve, which in November, 1929, took over a copper concession (granted in 1905) in the district of Terre Neuve, near Gonaives, set up a drill and employed four operators to determine the feasibility of a commercial exploitation of the deposit. Should the deposit be sufficiently large, a smelter will be installed; otherwise, the ore will be shipped in the raw state. The company is to pay an annual rental and 5 per cent of the sale price of the ore after deduction of the costs of transportation and reduction, whether in Haiti or in a foreign country.[8]

A reconnaissance of the mineral resources of Haiti was made between the years 1920 and 1922, under the direction of the United States Geological Survey, at the expense of the Haitian Government. In addition to the copper deposits and the indications of certain other ores, nonmetallic mineral resources were investigated. Lignite occurs in some abundance, and certain formations are considered favorable for the testing of oil. For further information, reference should be made to the voluminous report of Woodring and others,[9] from which the following quotation is taken:

> It is very possible that the country may contain valuable mineral deposits and that such deposits may be discovered by intelligent exploration. Moreover, many of the known low-grade deposits that are now valueless may become valuable through the general economic development of the country, improvements in methods of ore extraction and treatment, or enhancement in the value of metals, or a combination of these factors.

Rumors of the existence of minerals other than those reported by Woodring, Brown, and Burbank have arisen from time to time. Statements with regard to antimony are largely guesswork. Sulphur is claimed to be present in commercial quantities, but reliable data with respect thereto are lacking.

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8 LeMont, George D., Annual Report on Commerce and Industry: Consular Rept. 338928, Port-au-Prince, Feb. 14, 1930.

9 Woodring, Wendell P., Brown, John S., and Burbank, Wilbur S., Mineral Resources: Geol. of the Republic of Haiti, Dept. of Public Works, Port-au-Prince, 1924, pp. 423-425.

Occasionally small and isolated specimens of opal and chalcedony have been found, but no precise information regarding them is available. Nickel and tin also are mentioned among the minerals of Haiti by different writers. "The most probable minerals are gypsum, iron, coal, limestone, and building stone."[10]

TRANSPORTATION

Transportation conditions have not been particularly favorable to the development of the mining industry, because of the mountainous character of the country. In colonial days on the larger plains oxcarts and carriages were in use, the other parts of the colony being reached only by horseback. Since 1915 the highways have been improved as far as funds would permit.

> About 1,000 kilometers (625 miles) of highways have been improved or constructed since the beginning of the American occupation. Many bridges have been added to the road system in order to facilitate traffic. The most important of the new bridges is that which crosses the Limbe River in the northern part of the Republic. The completion of this bridge makes it possible to send produce by trucks from the Valley of Plaisance to Cape Haitien at all seasons.[11]

A recent report concerning the railroads of the Republic is as follows:[12]

> There are two companies operating in the country, the Central Railroad of Haiti, also known as the Cul-de-Sac Railroad, and the National Railroad of Haiti. The Central owns a line extending from Port-au-Prince, the capital, to the Dominican frontier, a distance of 35 miles (56 kilometers), and another line from Port-au-Prince to Leogane, 20 miles (32 kilometers).
>
> The National Railroad of Haiti has laid plans for the construction of a railway to traverse almost the entire country from north to south with several branches from the city of Gonaives in the northwest; a portion of this system has been completed. The main line will run from Port-au-Prince, passing along the coast, through Arcahaie, to St. Marc, 65 miles (105 kilometers) distant, which section is now in operation, then following the valley of the Artibonite River for about 115 miles (185 kilometers), passing Verrette, La Chapelle, Mirebalais, Las Coabas, and Hinche, and from there running northward, passing Pignon, Sacannette, Bahon, and Grande Riviere, to Cape Haitien, the principal northern seaport of Haiti, 205 miles (330 kilometers) distant.

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10 Rowe, L. S., and Borges, E. Gil, Haiti: Am. Nation Ser., No. 11, Pan Am. Union, Washington, D. C., 1928, p. 19.

11 Rowe, L. S., and Borges, E. Gil, Work cited, pp. 22-25.

12 See footnote 11.

At the present time the following railroads are in operation: Cape Haitien to Grande Riviere, 14 miles (23 kilometers); Gonaives to Ennery, 20 miles (33 kilometers); Port-au-Prince to St. Marc, 64 miles (103 kilometers); and Grande Riviere to Bahon, 10 miles (15 kilometers); or a total of 108 miles (175 kilometers).

The Artibonite River, which is navigable for 100 miles, is the only river that is passable for boats. The harbors of the country are excellent.

I. C. 6633

June, 1932

Department of Commerce

UNITED STATES BUREAU OF MINES
Scott Turner, Director

INFORMATION CIRCULAR

MINING LAWS OF THE UNFEDERATED MALAY STATES

BY

E. P. Youngman

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE--BUREAU OF MINES

MINING LAWS OF THE UNFEDERATED MALAY STATES[1]

By E. P. Youngman[2]

CONTENTS

1 - The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6633."

2 - Rare metals and nonmetals division, U. S. Bureau of Mines.

FOREWORD

This paper presents one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the rights of American citizens to explore for minerals and to own and operate mines in various foreign countries. This interpretation of the laws of the Unfederated Malay States has been prepared mainly from copies of the mining laws and ordinances now in force in each of the five States, obtained from Lester Maynard, American Consul General, Singapore, through the courtesy of the Department of State. It is released subject to correction and amplification, if necessary, by the proper American foreign-service officers, to whom it is being submitted through the Department of State.

INTRODUCTION

In the Unfederated Malay States, with the exception of Johore, the rights of suzerainty, protection, and administration were transferred by Siam to the British Government in 1909. In the States of Kelantan, Trengganu, Kedah, and Perlis, the rulers are assisted by State Councils and by British advisers appointed by the British Government.[3]

With respect to Johore, the largest, richest, and most highly organized of the Malay States not in the Federation, the treaty of December 11, 1885, with Great Britain, defined the relations of the State to the British Government and allowed the Maharaja to assume the title of "Sultan"; an amendment to this treaty (May 12, 1914) provided that the Sultan should be advised by a British officer, the General Adviser.

The political organization of the States is reflected in the mining legislation, Johore being the only one having a comprehensive code. The mining enactments now in force, according to the High Commissioner for the Malay States, are as follows:

State of Johore

1. Principal mining enactment, No. 12 of 1922 (July 19, 1922), which repealed No. 7 of 1911, No. 3 of 1912, and No. 9 of 1920.
2. Amending enactment, No. 14 of 1928 (October 4, 1928).
3. Amending enactment, No. 5 of 1929 (May 11, 1929).

State of Kedah

1. Principal mining enactment, No. 5 of 1347 (October 15, 1928), which repealed No. 7 of 1330, No. 18 of 1334, and No. 7 of 1337.

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3 - Epstein, M., The Malay States not Included in the Federation: The Statesman's Year-Book, 1930, London, 1930, p. 182.

2. Supplementing enactment, rules under the mining enactment 1347 (October 10, 1928).

State of Perlis

1. The mining enactment, No. 1 of 1340 (February 6, 1922?), which repealed No. 8 of 1333 and No. 4 of 1334.

State of Kelantan

1. The individual mining license rules, 1929 (Notification No. 27 of 1929), September 10, 1929.

State of Trengganu

1. The mining enactment, No. 3 of 1345 (July 1, 1927), which repealed No. 1 of 1336 and No. 2 of 1336.

2. Proclamation No. 1 of 1337, concerning acquisition by foreigners of mining land.

3. Regulations No. 2 of 1342 (December 24, 1923), with respect to the purchase of minerals.

Other laws of the Unfederated Malay States, either directly or indirectly related to the mining legislation (such as, land laws, land reservation laws, foreign company laws, and mineral buyers laws), to which access may be had in Washington are:

State of Johore

1. The land enactment, 1910, No. 2 of 1910, September 17, 1910 (amended by No. 5 of 1913, No. 21 of 1919, No. 8 of 1920, No. 6 of 1921, No. 8 of 1921, No. 5 of 1924, and No. 13 of 1928).

2. The foreign companies enactment, No. 5 of 1926, June 6, 1926 (an enactment to provide for the registration of particulars regarding companies incorporated outside Johore but having a place of business in Johore and for the holding of land in Johore by companies incorporated outside Johore).

3. The foreign companies rules, 1926, June 6, 1926 (notification No. 262, Johore Government Gazette Extraordinary).

4. An enactment to provide for the regulation of the purchase and smelting of mineral ores, enactment No. 1 of 1919, May 1, 1919.

State of Kedah

1. The land enactment, No. 7 of 1332, July 17, 1926 (amended April 1, 1930); and amendment of land rules, January 18, 1930.

2. The Malay Reservation Enactment, No. 6 of 1349, December 6, 1930 (repealing the Malay Reservations Enactment, No. 2 of 1340, and its amending enactment, No. 13 of 1346).

3. The foreign companies enactment, No. 7 of 1347, July 23, 1929 (amended by enactment No. 9 of 1349, January 3, 1931).

4. The mineral ore buyers enactment, No. 4 of 1346, November 24, 1927.

5. Tin and tin ore restriction enactment, No. 23 of 1349, March 1, 1931.

State of Kelantan

1. The land enactment, No. 3 of 1926, August 1, 1926.

2. The Malay Reservations Act, No. 18 of 1930, November 4, 1930.

State of Trengganu

1. The land enactment, No. 5 of 1344, July 11, 1926 (amended by No. 5 of 1347, June 8, 1929).

STATE OF JOHORE[4]

GENERAL

That the Government claims ownership of all the minerals of the State of Johore may be assumed. Ordinary land titles relate to surface rights only. (Art. 11, land enactment, 1910.) Only with the sanction of the Sultan in Council may a mining title be issued for land with respect to which any title other than a mining title has been issued and is in force. (Art. 130.) After any land has been alienated for agricultural purposes under permanent title, the right to mine it shall be granted only by the Sultan in Council. (Art. 12, Land Enactment, 1910.) The Sultan in Council, by payment of compensation, may resume for mining any land alienated for other purposes than mining (art. 128); and he may resume for public purposes land granted for mining operations (art. 42-f). The entire property in rivers, streams, and water courses throughout the State, save as such right may in any special case have been limited by an express grant made before the commencement of the mining enactment, is vested solely in the ruler of the State. (Art. 63.)

With respect to mining authority, the Sultan in Council may lease land for mining purposes and "may direct whether the right to mine shall be disposed of by public auction or tender or in compliance with an application lodged therefor or otherwise and whether premium shall or shall not be charged ...." (Art. 4.) Article 125 of the mining enactment gives him authority to formulate rules for carrying out the provisions thereof, the rules to have the force of law when published in the Official Gazette. The rules may relate to (1) premiums, rents, and fees; (2) the service of notices; (3) the sale of land by a chargee and the correction of errors in a lease or certificate;

4 All citations with respect to Johore, unless otherwise designated, relate to the principal mining enactment, No. 12 of 1922.

(4) powers and duties of officers; (5) schedule forms; (6) mining operations (alluvial, hydraulic, lode, or otherwise); (7) pipes for the conveyance of mineral oil and oil refineries; (8) prohibition of specified classes of labor in underground workings; (9) statistical returns by owners or managers; (10) fines under $1,000; and (11) any other matters, whether similar or not to those mentioned, that are considered necessary or desirable.

The Commissioner of Lands and Mines and the Collector duly appointed under the land enactment of 1910 are the officers having authority to receive applications for, and to grant (with the approval of the Sultan in Council), prospecting and mining rights, in general. Transfers, subleases, charges, and caveats with respect to mining lands are subject to the same officials.

Officials in charge of actual mining operations are wardens, assistant wardens, inspectors, and such other officers as the Sultan may consider necessary, whose duties and powers are enumerated in articles 99 to 113.

RIGHT OF THE GOVERNMENT TO RESUME MINING LAND

The right of the Government to the resumption of land for residential reserves or for public purposes applies to land acquired under a mining title. (Art. 42.)

Whenever it appears to the Sultan in Council that land is likely to be needed as a residential reserve or for any public purpose, a notification to that effect shall be published in the Gazette and posted at convenient places in the locality concerned. If after a survey has been made, it is determined that the land should be resumed, a declaration shall be published in the Gazette, together with particulars concerning the location of the land. Notices shall be served upon the occupier (if any) of the land and upon all persons known to be interested therein. (Art. 91, 94, and 96, land enactment, 1910.) The amount of compensation for retaken land is determined by article 116 of the land enactment of 1910. (See p. 8 of this paper.)

RIGHTS OF FOREIGNERS

That foreign individuals may obtain mining rights in the State of Johore is assumed, no special provisions with respect to aliens being incorporated in the mining enactment.

The foreign companies enactment,[5] No. 5 of 1926 (signed by the Sultan June 6, 1926) makes provisions for the registration of companies incorporated abroad but having a place of business in Johore, the holding of land to be deemed to be the establishment of a place of business, and the enactment to cease to apply immediately upon the disestablishment thereof. (Art. 1, 4, and 11.)

5 - Pryde, W., Enactment No. 5 of 1926, An Enactment to Provide for the Registration of Particulars Regarding Companies Incorporated Outside Johore, Etc.: The Laws of Johore, 1923-1927 (Revised up to and including Aug. 8, 1928), Singapore, 1928, pp. 305-308.

This law provides, among other things, that every company incorporated abroad shall, not later than three months after the establishment of a place of business, file with the Registrar of Foreign Companies, at Johore Bahru, a certified copy of its constitution, an authenticated list of its directors, and the names and addresses of residents of Johore authorized to accept service on its behalf. (Art. 3.)

Every foreign company having limited liability or using the word "limited" as part of its name shall in every document or publication relating thereto mention the name of the company and of the country in which it is incorporated. (Art. 6.)

PROSPECTING[6]

Private Property

The proprietor of land alienated for any purpose other than mining may himself prospect for metals or minerals or give written consent to another so to do, upon one week's notice to the warden.

A prospecting license for other than State land, which shall be granted by the Government, gives the licensee the right to a lease for any part of the licensed land, under the following conditions (Art. 57):

1. That the licensee shall have acquired all rights of other persons in the land desired for mining purposes or shall have paid the cost of the acquisition thereof and shall have actually acquired it.

2. That in the case of land reserved for a public purpose the reservation shall have been revoked.

State Land

A prospecting license covering State land confers upon the holder thereof the right to receive a mining lease for a selected area, or areas, included under the license, provided the Commissioner is satisfied that a sufficient amount of prospecting has been done and provided the prescribed premium has been paid. The Commissioner has authority to refuse a lease outright or to grant it for an area smaller than that requested. A prospective lessor must select the areas he intends to mine within three months from the date of the expiration of the original prospecting license or of any extension thereof. (Art. 56-i-a.)

It shall be lawful, generally or in specific instances, for the Commissioner (with the prior approval of the Sultan in Council) to grant prospecting permits to explore State land for metals, minerals, oil shales, or mineral oil, upon such conditions as may be set forth in the permit. A permit does not convey any right to a mining lease but does convey a prior right to a prospecting license over a definite portion of the area comprised in the permit. (Art. 60.)

6 - All citations with reference to prospecting are to the amending enactment No. 5 of 1929.

Licenses

The Commissioner, with the approval of the Sultan in Council, may grant licenses to prospect (a) State land alone or State land and alienated land (with the written consent of the Commissioner) for metals and minerals and (b) any land for oil shales or mineral oil. No license shall convey any right to prospect for oil shales or mineral oil unless such right is conferred in express terms. (Art. 50, 51, and 60.)

A prospecting license, which conveys an exclusive prospecting right (art. 56-b), which is not transferable (art. 54), and which is subject to such conditions as may be set forth therein, as well as to those in the mining enactments (art. 51 and 60), conveys to the licensee the right to do only such work as, in the opinion of the Warden, may be reasonably necessary to test the qualities of the land with respect to the metal, mineral, oil shales, or mineral oil specified in the license (art. 55). However, it shall be lawful for a licensee to remove from the land and to dispose of all metals or minerals raised during prospecting operations, upon the payment of such royalty or export duty as may be fixed by any law in force for the time being. (Art. 58.)

Application.--An application for a prospecting license, which shall be filed with the Commissioner of Lands and Mines, shall be in the prescribed form and shall indicate (1) the position, approximate area, and boundaries of the land to be explored, (2) the "metal or mineral" or the "oil shales or mineral oil" to be sought, and (3) the extent of the area over which the applicant desires the prior right to a mining lease. (Art. 52.)

The Collector, in case he approves an application, shall record it in the order in which it is received but so that priority of application shall give no priority of claim to a license. (Art. 53.)

Duration.--The period of each prospecting license is fixed by the Sultan in Council, which period under exceptional circumstances may be extended upon application by the licensee before the expiration of the original license and upon the payment of the required fee. (Art. 56--iv.)

Fees.--In addition to a prescribed fee, a licensee is liable for the cost (to be determined by the warden) of fixing the position of the land. (Art. 56--iii.)

Supervision.--Every licensee or other prospector shall submit to Government inspection and shall render (in a statutory declaration, if necessary) a full, true, particular, and just account of the results of his prospecting, within one month of the expiration of the license or of the completion of the work. (Art. 59.)

Damages.--A licensee of land other than State land shall be liable for damages to the proprietor, lessee, or lawful occupier in the case of alienated land and to the person having control thereof in the case of reserved land. The amount of such damage shall be assessed in conformity with part 8 of the

principal land enactment, of 1910, unless a mutual agreement is reached by the parties concerned. (Art. 51-iii.)

Part 8 of the land enactment of 1910 provides that, after appraising the land, the Collector shall determine the amount of compensation due for damage (art. 99) and in case of nonagreement as to the apportionment thereof shall settle the dispute, subject to appeal to the court. (Art. 100); if the Collector is unable to agree with the parties as to the amount of damage due, he shall refer the matter to arbitrators, chosen by the parties at interest and by the Government (Art. 102-110); and if the arbitrators are unable to agree upon a settlement, the Collector shall submit the case to the court. (Art. 111-117.)

The amount of compensation due to the person interested shall depend upon the following particulars (Art. 116 of the land enactment, 1910):

1. The fair market value of the land at the date of the publication of the notification and declaration.

2. The damage, if any, sustained at the time of awarding compensation through the severance of the land in question from other land he may hold.

3. The damage, if any, sustained to other property (whether movable or immovable) or upon his actual earnings.

4. If in consequence of the acquisition he is compelled to change his residence or place of business, the reasonable expenses, if any, of such change.

Cancellation.--Every prospecting license is liable to cancellation by the Sultan upon proof of a breach by the holder thereof of any of the conditions attached to it or of any of the provisions of the mining enactments. (Art. 62.) At any time after the first three months from the issuance of a license, the Sultan may cancel the prospecting right if the licensee has failed within the three months to make a bona fide commencement of work or if he has abandoned prospecting for a certain period (to be stated in the license). (Art. 56-v.)

MINING TITLES

Mining leases for State land are issued in the name of the Sultan in Council, under the State seal, subject to varying terms with respect to area, period of duration, annual rent, and number of coolies to be employed. No lease shall vest in a lessee any right to take any oil shales or mineral oil, coal, or iron ores unless such right is conferred in express terms by the lease, certificate, or other document. (Art. 4 and 5.)

Mining titles are subject to the land laws of the State with respect to the following matters (art. 42):

1. Demarcation and survey by collectors, settlement officers, surveyors, demarcators, or land measurers appointed by and acting under the Sultan in Council. (Art. 68 to 77, pt. 6, land enactment of 1910.)

2. Collection of land revenue. (Art. 78 to 90, pt. 7, land enactment of 1910.) (See p. [illegible] of this paper.)

3. Subdivision of lands. (Art. 22, pt. 1, land enactment of 1910.)

4. Loss of documents of title. (Art. 17, pt. 1, land enactment of 1910.)

5. Certified copies of documents of title. (Art. 16, pt. 1, land enactment of 1910.)

6. Acquisition of land for residential reserves or public purposes. (Art. 91 to 125, pt. 8, land enactment of 1910.) (See p. 5 of this paper.)

Mining Leases

Application

An applicant for State land for mining purposes shall file with the Collector an application in the prescribed form and deposit a sum of money to cover the required fees. The application must set out the position and approximate area of the land desired. It shall give an address at which notices may be legally served. An applicant may at any time, upon payment of all expenses, cancel his application.

The Collector, if he deems the application worthy, shall record it in the Land Office in the order in which it is received but so that priority of application shall not give priority of claim to a lease. If the application is approved, permanent boundary marks shall be erected, and the land shall be surveyed. (Art. 6, 7, 8, and 10.)

Should an applicant whose application has been approved desire to commence mining before the completion of the survey, the Collector (with the written consent of the Commissioner) may, after the land has been demarcated, issue a preliminary lease (mining certificate), to confer the same rights and privileges and to be subject to the same conditions, obligations, and liabilities as the lease to be issued subsequently and dated from the issuance of the certificate. (Art. 9.)

Upon the receipt of a certified plan (including area, boundaries, abuttals, and the position of boundary marks), the Collector shall have a lease prepared for the signature of the applicant. Nonappearance of the applicant, upon notice from the Commissioner, within three months of the date of notification may result in the cancellation of the application. The cancellation of the lease or of an existing mining certificate likewise may follow failure of the applicant to appear to accept the officially signed and sealed lease and to pay the required fee, within three months of notification so to do. (Art. 10, 11, and 13.)

Rights and Obligations of Lessees

Rights of lessees of other than oil rights.--A lease for other than oil land grants to the holder thereof the right to work all metals and minerals (except oil shale and mineral oil) found beneath the land and to remove, dispose of, dress, and treat them during the term mentioned in the lease. (Art. 15--i.)

It likewise confers surface-land rights for the erection of necessary houses, coolie lines, sheds, or other buildings or for growing necessary plants and vegetables or for keeping animals and poultry. (Art. 15--ii.)

It gives also the exclusive right to the use of all timber and other jungle produce (except as the Government may claim them) upon the land but no right to remove, without a license, beyond the boundaries of the land (except for the extraction of metal or mineral ore) any timber or other jungle produce or any granite, limestone, laterite, or other stone, coral, shell, guano, sand, loam, or clay obtained from the land, or any bricks, lime, or other commodities manufactured from these materials. (Art. 15--iii.)

Rights of lessees of oil land.--A lease for oil land grants to the lessee the right within the area specified to produce and treat all oil shales and mineral oil and to dispose of the products. (Art. 16--i.)

It gives also, in addition to all the rights of lessees of other than oil land in so far as they are applicable, the right to sink, construct, and maintain such wells, workings, borings, pipe lines, fittings, and appliances as may be necessary or proper for working, raising, treating, or conveying oil shales and mineral oil in or from the allotted area. (Art. 16--ii.)

Obligations of all lessees.--Every lessee (whether he may have subleased the land or any part thereof) and every sublessee and occupier are subject to the following obligations (Art. 17-19):

1. Boundaries.--To maintain all landmarks defining boundaries and keep boundary lines open.

2. Posting of notices.--To post, at the principal office and wherever business is conducted or coolies housed, notices, including the name and address of the lessee, of the occupier, and of the advancer and the number and title under which the land is held; and to post in a conspicuous place upon any specified building copies of such documents in such languages as the warden may require.

3. Commencement of mining.--To commence operations within a period of six months from the issuance of the lease, to employ the prescribed number of coolies within a further period of six months (or labor-saving apparatus equivalent thereto at the rate of one horsepower to eight coolies). (Exemption may be granted, upon payment of the prescribed fee, by the Sultan in Council.)

4. Mode of operating.--To carry on all mining operations in an orderly, skillful, and workmanlike manner.

5. Safety of miners.--To take due precaution to insure the health and safety of miners and other workmen and to comply with all requirements in relation thereto made by the warden.

6. Access to adjoining land.--To permit access to adjoining land when, in the opinion of the warden, such access will not interfere with rights under the lease.

7. Resumption of land for public purposes.--To surrender (when called upon by the Commissioner) such portions of the leased land as may be required for public or private roads, canals, bridges, towpaths, railways, tramways, or other works of public utility or convenience. (Compensation to the lessor shall be assessed in the manner prescribed by part 8 of the land enactment, 1910.) (See pp. 5 and 8 of this paper.)

8. Removal of road-making material.--To permit the removal of any earth, stone, gravel, timber, or other road-making or building material required by the State for any public purpose.

9. Rent and royalty.--To pay the prescribed quitrent and royalty due to the State at the time and the place designated.

10. Access to land by Government officials.--To permit Government officials free access to land, workings, and buildings.

Additional obligations of lessees of other than oil land.--Every lessee of other than oil land is subject to the following obligations also (Art. 17):

1. Surrender of oil land.--To surrender to the State any land or portion thereof found to contain oil shales or mineral oil, within one month from the service upon him of a written notice by the State Secretary so to do, provided the lessee shall receive reasonable compensation with respect to any loss or damage sustained because of such surrender. (Compensation shall not include any sum on account of the value of any oil shales or mineral oil that the land may contain.) Compensation shall be assessed in the manner provided by part 8 of the land enactment, 1910.) (See pp. 5 and 8 of this paper.)

2. Lode formations.--In case the lessee when working alluvial deposits discovers lode formations (lodes, beds, pockets, stockworks, or similar formations) and the State Secretary requires him to work them, to commence work in a proper and workmanlike manner within 12 months from the date of the requisition or, in case of default, to surrender to the State (if so required) such portion of the land as it may direct. (Compensation shall not include any sum on account of the value of any mineral deposit that the lessee has failed to work, and such compensation shall be assessed according to part 8 of the land enactment, 1910.)

3. Account books.--To keep true and sufficient books of account of the mining and other business carried on upon the land and of the disposal of metals and minerals obtained and to produce (upon request) such books for inspection.

Additional obligations of lessees of oil land.--Every lessee of oil land is subject to the following obligations also (art. 18):

1. Position of new wells.--Not to make or sink any new bore or well within 1,000 yards of any oil well sunk outside the land comprised in the lease, except upon the written authority of the warden.

2. Protection of wells.--To secure by durable means all oil wells and bores made or sunk in the land and, if so required by the warden, to fence them.

3. Pipe lines across land.--To permit the Government or any person authorized thereby to enter upon the land and to construct or lay thereon all such channels and pipes as may be reasonably necessary for the conveyance across the land (or of any part thereof) of mineral oil won elsewhere and to inspect, repair, and maintain all channels or pipes so constructed or laid and, in general, to do all that may be reasonably necessary to convey mineral oil across the land. (See also article 76.)

4. Storage tanks.--To provide and maintain in such position as the warden may approve storage tanks of such design as he may sanction, capable of containing all mineral oil won or got under the lease and fitted with pipes, meters, and other means for ascertaining the quantity of oil entering and withdrawn, and to permit persons authorized by the warden to be present in order to keep separate accounts and to check their accounts with those of the lessee.

5. Testing of tanks.--To permit persons authorized by the Government to examine and test the tanks and meters and other appliances and upon the written order of the warden to repair them. If in the examination anything should be found prejudicial to the Government with respect to royalty, such error shall be deemed to have existed for the three calendar months previous to the discovery or from the last examination (if it is within the three months), and the royalty due by the lesseee shall be paid or accounted for accordingly.)

6. Oil for the British Admiralty.--To comply with all conditions placed by the Sultan in writing upon the lessee, in order to obtain an adequate supply of oil for the ships of His Brittanic Majesty's Navy or for other purposes of the British Admiralty and in order to secure the refinement in the State, the Federated Malay States, or the Straits Settlements of all mineral oil won under the lease.

7. Safety measures.--To take all such measures as the warden may impose to obviate danger by fire or explosion.

8. Compensation for damages.--To make full and reasonable satisfaction for all damage and injury caused in operations under the lease and to save harmless and keep indemnified the Ruler, the Government, and the warden from demands made with respect to such damage or injury.

9. Plans.--To keep true and correct plans showing the location of all wells and borings, as well as all operations and workings, and to furnish to the warden true and correct copies thereof, when so required.

10. Accounts.--To keep accurate books of account showing (1) the amount of oil won and brought to the surface from wells and bores, (2) the number of persons employed, and (3) all facts necessary to determine the amount of royalty (if any) payable. (The lessee shall furnish to any officer appointed by the Sultan true abstracts of all accounts.)

11. Transfer.--Not to transfer or sublease the land or any part thereof or interest therein without the previous written consent of the Sultan.

12. Procedure upon expiration of lease.--Upon the expiration or other determination of the lease, to deliver to the State Secretary all oil wells (in good repair and condition) other than those abandoned with the consent of the Sultan, together with all immovable engines and fixtures below ground.

Special obligations of lessees of oil, coal, and iron land.--The lessees of land for the working of mineral oil, coal, or iron ore, in the absence of any express provision to the contrary, shall be subject to the following obligations (Art. 19):

1. Preemption by State.--Whenever so required by written notice from the Sultan, the lessee shall reserve for sale to the Government all or such part as may be required of the mineral oil, coal, or iron ore won or the products therefrom.

2. Price.--The price to be paid shall be (1) that specified in a separate agreement or (2) in case no prior agreement was entered into, the fair market price, to be arranged between the Sultan and the lessee. In default of agreement, the price shall be determined by two arbitrators, one chosen by each party to the matter, with power to appoint an umpire in case of disagreement; and such "reference shall be deemed to be in pursuance of a submission within the meaning of the arbitration enactment, 1919, or any statutory modification or reenactment thereof for the time being in force."

3. Increase of production.--A lessee is required to use his utmost endeavors to increase the supply of mineral oil, coal, or iron ore, or of the products thereof, whenever the Sultan in Council shall judge that a state of emergency exists and shall give written notice to that effect.

4. Government control of plant in case of emergency.--In the event of war or on the occasion of a state of emergency, the Sultan in Council may take control of the leased land and of the works, plant, and premises of the lessee. Compensation shall be paid to the lessee for any loss or damage that may be proved to have been sustained, such compensation to be settled by agreement between the Sultan and the lessee or by arbitration in default of agreement. (For control of refineries, see article 77.)

Renewal

The renewal of a lease may be obtained through a written application therefor to the Collector, made 12 months before the expiration of the original lease, if the Sultan in Council is satisfied that the lessee has complied with the covenants and conditions of the lease. (Art. 26.)

Transfer

Any title to occupy land for mining purposes (granted prior or subsequent to the mining enactment) shall not be capable of being transferred, transmitted, subleased, charged, or otherwise dealt with save in accordance with the provisions of the enactment, exception being made of subleases for a period not exceeding 12 months. (Art. 31.)

Any person wishing to transfer, sublease, or charge[7] his land shall deliver to the Commissioner the document of title under which the land is held together, with a memorandum of transfer. Application for right to sublease must be accompanied by a plan, colored red, of the land to be subleased. The signature of every party (transferor or transferee) must be attested by designated officials. (Art. 32.) The officials authorized to attest the documents of transfer are given in section 2 of the mining amendment (enactment No. 14 of 1928), which repeals subsection 3 of article 32 of the principal enactment.

Upon receiving payment of the prescribed fees and arrears of rent that may be due, the Commissioner shall indorse upon the document of title a brief record of the nature of the dealing, the names of the parties at interest, the date, and like matters. A similar record shall be indorsed upon the duplicate copy of the document of title. After registering the transfer or other transaction, the Commissioner shall return the document of title to the party entitled to the custody thereof. (Art. 33 to 35.)

For further details with reference to subleases, sale of land by charges, transmission of land to heirs, caveats, and related matters, see articles 31-43 of the principal enactment, together with article 50 of the land enactment, 1910.

Surrender

Voluntary surrender of mining land may be made at any time by a lessee upon application to the Collector, upon payment of all arrears due and of all

7 - See footnote 8.

fees and charges[8] that may be incurred in ascertaining the position and area of the land to be surrendered, and upon the forwarding of the lease to the Collector for cancellation. Payment of arrears in rent may be remitted, with the approval of the Commissioner. If a part only of the land is to be surrendered, application shall be made to the Collector to have such part demarcated and surveyed, together with the submission of the lease and the deposit of the amount of fees and charges incident to such surrender.

The Commissioner may accept the surrender of any land in respect to which all the requirements of the mining enactments have not been met. (Art. 27.)

Forfeiture

Causes.--Liability to forfeiture (art. 21-25) of a mining lease may be incurred not only for failure of the lessee to comply with any of the obligations or conditions for breach whereof the lease may be expressed to be forfeitable, but also for breach of certain of the obligations included in the mining enactment (discussed on pages 10 to 13 of this paper), as follows:

Leases for other than oil land may be forfeitable for--

1. Failure to pay rent or royalty, where the breach has continued for six months or more.

2. Failure to commence operations within the specified time (six months), except in so far as exemption may have been granted by the Sultan.

3. Failure to surrender oil-shale or mineral-oil land.

Leases for oil land may be forfeitable for--

1. See Nos. 1 and 2 above.

2. Failure to keep books of account with respect to amount of oil produced or number of workmen employed.

3. Failure to maintain storage tanks or to permit their inspection by Government agents.

4. Failure to reserve the required oil for the Admiralty.

5. Failure to provide adequate protection against fire and explosion.

6. Failure to comply with the ruling against transfers and subleases.

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8 - "Charge" means any charge created on land for the purpose of securing the payment of money and also the instrument by which the charge is created.

Leases of mineral oil, coal, or iron ore may be forfeitable for breach of any of the conditions concerning preemption of the oil output by the State, price to be charged for the product, arbitration of the price, increase of production, or Government control of plant in case of an emergency. (See pp. 13 and 14 of this paper.)

Procedure.--The Collector, with the approval of the Commissioner, serves a notice in the form prescribed, calling upon the lessee (within a specified period of not less than one month) to show cause why the lease should not be forfeited.

The rule to show cause why shall be personally served upon the lessee, if possible; if not possible, by any method under rulings formulated by the Sultan under the authority given by article 125.

A duplicate of the rule to show cause why shall be posted in a conspicuous position on the land comprised under the lease. Notification of the forfeiture shall be made in the Gazette, together with a declaration that the land has reverted to the State; and a duplicate notice thereof shall be conspicuously posted on the land. Without such procedure, no forfeiture shall be effective. A copy of the Gazette containing notice of forfeiture shall be conclusive evidence in any court of justice.

Any quitrent already received for the year in which the forfeiture is enforced shall be repaid to the lessee.

Mining Licenses

A registered proprietor or lessee holding a title for surface rights may apply to the Collector for a proprietary mining license to work minerals beneath his land or any part thereof. (Art. 44 and 45.)

The Collector may, with the approval of the Sultan in Council, and with the express consent of all persons having registered interests (by way of charge or otherwise), and after the payment of any premium that the Sultan may impose, issue to the proprietor or lessee a license to work, remove, dispose of, dress, or treat all mineral ores found beneath his land or any part of it during the continuance in force of the surface-land title or during such lesser period as may be stated in the license, subject to the provisions of the mining enactment and to the payment of the prescribed rent.

Once a mining license has been granted, the mineral rights are no longer divorced from the surface rights; and henceforth every transfer, sublease, charge, or other dealing with the surface-land title shall extend to and include the mining rights created by the license, and vice versa.

Conditions.--Since the land under a proprietary license is deemed to be mining land and the license to be a document of title to mining land (with minor exceptions), every such license is under the provisions for surrender and forfeiture of leases and under the same conditions that attach to leases

not expressed to be for mineral oil only with respect to (1) quitrent and royalties, (2) boundaries, (3) mode of conducting work, (4) access to workings and buildings by Government agents, (5) posting notices of ownership, etc., (6) removal of road-making materials by the Government, (7) books of account, (8) access to adjoining land, (9) protection of miners. (See pp. 10 to 12 of this paper.)

In addition, every proprietary license is subject to the following conditions and limitations:

1. The licensee shall work only in such manner as may be approved by the warden.

2. The license shall be liable to cancellation by the warden should the licensee default in the observance of any of the conditions of the license or of the mining enactment or disregard any lawful order of the warden or the inspector.

3. The licensee shall give advance written notice to the warden of the date on which work is to be begun or of the date of cessation of work.

Individual

The Collector may issue (with the approval of the Commissioner and for a prescribed fee) a license conveying a right only to the person named therein to mine any mineral deposit other than oil shales or mineral oil within an area defined in the license. (Art. 46 to 48.) Such a license does not confer a title to the land and remains in force only until December 31 of the year in respect to which it is issued. It is not transferable. It shall be carried upon the person of the licensee at all times when he is engaged in any work thereunder, and it shall be produced whenever lawfully required. The licensee is required to work only in such manner as the warden or an inspector may approve. Immediate cancellation may result upon default by the licensee in observing any of the conditions of the license or any of the provisions of the mining enactment.

Lombong Siam[9]

No underground working of such nature as "lombong Siam" may be carried on by any occupier of mining land without a license from the warden (unless the terms of his document of title expressly permit it).

If the warden refuses such a license or imposes conditions as to construction, timbering, or other matters, he shall state his reasons therefor in writing at the request of the applicant. (Art. 86 and 87.)

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9 - Lombong (lumbong) is used for open-cast mines and shafts. "Open-cast mine is an excavation for the purpose of extracting ore, open to the heavens, with sides theoretically at an angle of safety, compared with the angle of rest of the material composing the said sides." (Scrivenor, John Brooke, A Sketch of Malay Mining: Mining Publications (Ltd.), London, 1928, pp. 73-76.)

Every such license shall be in the prescribed form and shall (a) describe the limits of the land; (b) contain such conditions as may be necessary for the protection of life and property; and (c) be liable at any time to cancellation or alteration by the warden because of a breach of the terms of the license, or because the warden has decided that further work can not be carried on efficiently or safely. (Art. 88.)

Hydraulic

The working of land by ground sluicing or by any other method of removing earth by water power requires a special license from the warden. (Art. 93.)

The warden may issue the proper license for a period not to exceed 12 months or, with the sanction of the Sultan, for any specified period. (Art. 94.)

Additional conditions are as follows (Art. 95 and 96):

1. The applicant shall lodge in the Treasury a sum of money sufficient to defray the cost of removing waste matter (to such land as the license shall state) and of compensating the owner of the land on which the waste is deposited. Such a deposit shall not be deemed to be a full discharge of the liability of the applicant, however. (Art. 95.)

2. The warden shall have power to cancel or suspend the operation of the license for such period as he thinks fit, if the licensee has failed to comply with the conditions of the license or by his operations has endangered or prejudiced the rights of the State or of any other person. (Art. 96.)

MISCELLANEOUS

Water rights.--The warden may issue to any person holding a mining title a license to divert and make use of such water as is therein mentioned, upon such conditions as he may think fit. A water license is issued for 12 months, unless the Sultan shall approve a longer period; it is renewable at the discretion of the warden. (Art. 66.)

The Sultan may grant, for a stated period and purpose, a license to construct upon or through State or alienated land any pump, line of pipes, flume, race, drain, dam, or reservoir and to use all waters therefrom in such quantities and in such manner as may be necessary, in the opinion of the Sultan, for working the lands specified in the license. Such a license is revocable if not exercised for a period of two consecutive years. (Art. 71.)

Articles 63 to 75, inclusive, contain further provisions with respect to water rights, principally with reference to (1) use of water wheels, (2) obligation of licensee to permit use of outflow to others, (3) purification of the water, and (4) cancellation and revocation of the license.

Rent and royalty.--All minerals or metals won within the State shall be subject to such royalty as the Sultan in Council may fix by notification in the Gazette. (Art. 126.) The Sultan may commute, generally or individually, a royalty for a fixed annual payment (commutation fee). (Art. 127.)

Collection of land revenue.--The collection of land revenue is subject to articles 78 to 90 of the land enactment of 1910. (Art. 42.)

Any one defaulting in the payment of rent or revenue due to the State with respect to land shall be subject to an attachment upon his personal property. If a notice to pay and an attachment do not recover the sum due, the Collector may issue a notice of sale; and if the arrear is not paid within the succeeding four months, the Collector may sell, by public auction, the whole or a part of such land or such interest therein as he may think sufficient to satisfy the arrear and the costs of the proceedings. If any person tenders the amount of arrear and costs at any time previous to the sale, the Collector shall desist from further proceedings. If at any sale of such property no bid is sufficient to cover the sums due, the land shall revert to the State.

Trespasses and penalties.--Fines and penalties (art. 114 to 124; art 4. of amendment No. 5 of 1929), ranging from $50 to $1,000 and from one to three months' imprisonment, are imposed for (a) illegal occupation of land for mining purposes, (2) neglect to comply with legal notices, (3) default in observing conditions of title to mining land, (4) erecting buildings other than those specifically authorized, (5) default of terms of an individual mining license, (6) default of terms of a prospecting license, (7) contravention of provisions concerning water supply, (8) contravention of the regulations concerning the extraction of oil from oil shales, the refining of oil, or the reserve of oil for the British Admiralty, (9) disobedience of orders of wardens or inspectors, (10) and criminal negligence on the part of employees.

An employer is responsible for a breach of mining regulations (and for the penalty attached thereto) on the part of miners and workmen unless he can prove to the satisfaction of the court that the breach was committed without his knowledge or consent and that he had taken reasonable measures to prevent it. However, nothing contained in this provision shall exempt a miner or workman from liability for any breach proved to have been committed by him. No title, license, or other authority issued under the mining enactment shall exempt any person from liability for damage done to the property of the Government or to that of any person. (Art. 130 and 131.)

Mining operations.--Articles 78 to 85 and 89 to 92, all inclusive, cover rules with respect to the following matters: (1) Keeping boundaries open, (2) storing explosives or other inflammable substances, (3) reporting mine accidents, (4) depositing overburden and tailings, (5) fencing, timbering, and supporting shafts, adits, levels, galleries, and underground passages, (6) maintaining ladderways, and (7) providing ventilation.

Purchase, storing, and smelting of ore.--No one except a licensee of the Government has the right (1) to purchase any mineral ore, (2) to keep any factory or place for the purpose of smelting or otherwise treating mineral ore,[10] or (3) to keep any house, store, shop, or place for the purpose of purchasing or storing therein any mineral ore other than such as has been raised from land in his own occupation. A license to purchase, treat, and store mineral ore may be obtained from the Commissioner upon the payment of a fee of $100 and a deposit of $200. (Enactment No. 1 of 1919, May 1, 1919.)

KEDAH[11]

GENERAL

The mining legislation of Kedah, although far less comprehensive than that of Johore, resembles it in many details.

The provisions of the mining enactment make no reference to other than State land. The land law (land enactment 1332), however, has the following provisions:

> Every surat putus, surat kechil, lease, or permit shall be deemed to vest in the person entitled thereunder a surface right only in the land to which such document relates and shall convey no right to remove, without license duly issued under this enactment, any gravel, sand, or clay or to make bricks or burn lime for the purpose of profit. (Art. 7.)
>
> All tin, gold, coal, petroleum, and other minerals, and all guano deposits are the property of the Government, and no operations to work such minerals or deposits may be carried out upon lands held under any surat putus, surat kechil, permit, or other similar document issued under this enactment or at any period in the past, with the exception of those surat putus that have been issued prior to the date of this enactment with the special provision duly indorsed thereon permitting the owner of the land described therein to work the said land for tin or gold or other mineral. (Art. 4.)
>
> Except with the permission of the State Council no mining lease shall be issued for any land that has already been alienated for agricultural purposes under surat putus, surat kechil, permit, or other document. (Art. 5.)
>
> All seashores and shores in tidal rivers below high-water mark at ordinary high-spring tide are the absolute property of the Government; and all rights of foreshore and accretions are vested in the Government solely. (Art. 6.)
>
> All rivers, streams, and canals throughout the State are the absolute property of the Government, which has the sole right of control thereof. (Art. 8.)

10 - "Mineral ore" does not include gold.
11 - The citations in the section of this paper relating to the State of Kedah are to the principal mining enactment, No. 5 of 1347 (Oct. 15, 1928), unless otherwise indicated.

The Sultan has authority to appoint a Superintendent of Mines (including an assistant superintendent), inspectors of mines, and such other officers as it may consider advisable, all to be deemed public servants within the meaning of the Penal Code. (Art. 3 and 36.)

The Superintendent of Mines, in addition to his duties in connection with the issuance of licenses and leases, has broad judicial and executive authority. He has the powers of a magistrate of the first class for carrying into effect provisions of the mining enactment, compelling the attendance of witnesses, and maintaining order in court. (Art. 37.) He may decide disputes between occupiers of mining land, and he has power to make any order necessary to give force to his decisions. He may order the payment of compensation (not in excess of $500) by any party to a dispute (art. 38) and is empowered to decide any issue (concerning mining operations or mining land) transferred to him by any civil court other than the High Court (art. 39). Any civil court shall enforce any decree of the Superintendent of Mines, provided a certified copy thereof has been forwarded to the court, with a request for its execution. (Art. 40.) A Special Court, composed of judges of the first and second divisions of the High Court, is the final court of appeal from decisions of the Superintendent. (Art. 41.)

The President of the State Council may make rules concerning (1) premiums, rents, and fees, (2) service of notices, (3) powers and duties of officers appointed under the mining enactment, (4) alteration or rescinding of schedule forms, (5) regulation of mining operations, (6), account books and records of mine owners or managers, and (7) any other necessary or desirable matter. (Art. 49.)

RIGHTS OF FOREIGNERS

It is assumed, as in the case of Johore, that foreigners are permitted prospecting and mining rights in Kedah, for the same reasons: namely, that the law contains no express provision to the contrary and that a foreign companies enactment (No. 7 of 1347--July 23, 1929) provides that alien companies may establish a place of business in the State and that the holding of land shall constitute the establishment of a place of business.[12]

However, the Malay Reservations Enactment No. 6 of 1349 seems to restrict the rights of foreigners. This act, which defines "Malay" as "a person belonging to any Malayan race or a person of Arab descent who habitually speaks the Malay language or any Malayan language and professes the Muslim religion," contains the following provisions:

> It shall be lawful for the State Council to declare by notification in the Gazette any area of land (except Sanitary Board areas and township areas) to be a Malay reservation. (Art. 4.)
>
> No right or interest of any Malay in reservation land shall, except in the pursuance of a sale effected with the consent of the President of the Council . . . be transferred to or vest in any person not being a

12 - The foreign companies law of Kedah is practically identical with that of Johore.

Malay, provided that nothing in this section shall be deemed to prohibit the leasing of reservation land to persons other than Malays for any term not exceeding three years . . . . (Art. 7.)

No State land included within a Malay reservation shall be sold, leased, or otherwise disposed of to any person not being a Malay. (Art. 8.)

If at any time it be shown to the satisfaction of the State Council that any person who is not a Malay or any company not wholly composed of Malays holds any interest in reservation land whereof the registered owner is a Malay or a company composed wholly of Malays, other than as a lessee under this enactment or a registered chargee, the title to such land shall be liable to forfeiture. . . . (Art. 9.)

No right or interest of any Malay in reservation land shall be sold in execution of a decree to any person not being a Malay. (Art. 11.)

No right or interest of any Malay in reservation land shall be sold at the instance of a chargee of such land without the consent of the President of the State Council . . . . (Art. 12.)

The right and interest of any Siamese in reservation land may be transferred to and vest in any person of Malay race or to a Siamese born in the State, but shall otherwise be subject to all the conditions and restrictions imposed by this enactment. (Art. 18--ii.)

SPECIAL PROVISIONS WITH RESPECT TO TIN

In view of the international agreement between the governments of the principal tin-producing countries of the world, Kedah enacted a law to "restrict, regulate, and control the production, possession, sale, purchase, and export of tin and tin ore." (Tin and tin-ore restriction enactment, 1349.)

No decisions made in the exercise of the powers conferred by this enactment by any officer or other person appointed thereunder regarding the quantity of tin or tin ore that may be produced, sold, purchased, exported, or held in the possession of any person shall be called in question in any court of law; and no civil suit shall be instituted against the Government with respect to to any matter arising under the enactment. (Art. 4 and 5.)

Nothing in this enactment shall affect the provisions of the mineral ore buyers enactment, 1346. (See section of this paper entitled "Miscellaneous.")

PROSPECTING

Either a general or an exclusive prospecting license may be issued by the Superintendent of Mines,--an exclusive license requiring the approval of the State Council also.

A general license is limited to a period of six months and carries with it no right to a mining lease, whereas an exclusive license is granted for one year and gives the licensee the right to a lease, provided he can prove to the State Council that he has done a sufficient amount of prospecting work. (Art. 24 to 26.)

MINING TITLES

A lease for mining land, granted by the Sultan with the approval of the State Council, shall contain a description of the land, together with the boundaries thereof. (Art. 4 and 9 and schedule D.) It shall cover all minerals (to the exclusion of mineral oil or oil shale unless express provision is made therefor) upon or beneath the land described in the lease, unless the President of the State Council shall add to or limit this right. (Art. 8 and 11.)

Every lease of mining land shall be subject to the land laws of the State with respect to (a) demarcation and survey, (b) collection of land revenue, (c) subdivision of land, (d) loss of documents of title, (e) caveats, and (f) foreclosure. (Art. 23.)

Application

An application for a mining lease must be prepared in the form prescribed and filed with the Mining Office. It shall (1) state the position and the approximate area of the land desired, (2) give an address at which legal notices may be served, and (3) be accompanied by the required fee. (Art. 5.)

The Superintendent shall register each application in the order in which it is received, "but not so as to give a claim of priority to the issuance of a lease."

When an application has been approved, permanent boundary marks shall be erected and the land surveyed. Should the applicant desire to commence mining operations before the completion of the survey, the Superintendent may grant him a provisional lease, under practically the same conditions and obligations as the permanent lease, to be exchanged therefor. The President may at any step in the procedure refuse a lease, except to the holder of a provisional right. (Art. 6 to 10.)

Duration

A lease is issued for 21 years to the lessee, his heirs, successors, and assigns. (Schedule D.)

By filing a written application with the Superintendent 12 months before the expiration of the original lease, a lessee may receive a new one, if he can prove to the satisfaction of the President of the State Council that he has compiled with the obligations and conditions of the original. (Art. 16.)

Work Required

A lessee shall commence bona fide mining within six months from the date of the lease; within a further six months he shall have at work not less than such number of coolies as shall be mentioned in the lease (or labor-saving apparatus equivalent thereto), the number of coolies to be not less than one for every two relongs of land. The lessee shall employ continuously throughout the period of his lease the number of laborers or the machinery and plant required. Exemption from these provisions may be permitted only by the President of the State Council, on such terms as he may consider reasonable. The lessee shall carry on all mining operations in an orderly and skilful manner. (Art. 12.)

Rights and Obligations

In addition to the rights and obligations expressed or implied in the preceding paragraphs, each lessee has the same rights as lessees in the State of Johore with reference to the use of land for auxiliary purposes and to the use of timber and forest products. Each lessee is likewise under the same obligations as lessees in Johore, with respect to (a) payment of rent and royalty, (b) posting of ownership notices, (c) preserving boundary marks and lines, (d) granting permission to the Government to remove from his land road and building materials, (e) keeping accounts, (f) permitting access to adjoining land, and (g) taking proper safety measures. (Art. 12.) (See pp. 10 to 14 of this paper.)

Transfer

Any title to occupy land for mining purposes may be transferred, transmitted, subleased, charged, or otherwise dealt with under the provisions contained in articles 19 to 22 of the mining enactment.

Surrender and Forfeiture

A lease-holder may surrender his land or any part thereof upon application to the Superintendent and upon the payment of all necessary fees and arrears of rent (if any) due to the Government. The Superintendent may refuse to accept the surrender of land with respect to which the provisions of the mining enactment have not been fulfilled. (Art. 17.)

A lease is forfeitable for any breach of the special conditions attached to the lease and for any violation of the provisions of the mining enactment. (Art. 13.) The Superintendent must by notice summon the lessee to show cause to the State Council why his lease should not be forfeited. If the lessee shall fail to prove his case, notification of forfeiture shall be published in the official Gazette, and the land shall revert to the State. (Art. 15.)

Rent already paid for the year in which the forfeiture takes place may be returned upon demand made within a year from the date of forfeiture. (Art. 14.)

MISCELLANEOUS

Water Rights

No change in the water supply of any land under a mining lease shall be made without the written permission of the Superintendent, approved by the Waters Board. (Art. 28.)

Any lessee failing to comply with the provisions concerning the prevention of water pollution may be required by the Superintendent to construct such walls and dams and to introduce such chemical methods as he deems necessary. (Art. 29.)

Rent, Premiums, and Fees

A lessee shall pay the rent and royalty (premiums?) that may become due to the State in accordance with the provisions of the mining enactment and any rules thereunder, as a condition of the lease. (Art. 12.) Rental for a mining lease shall be at the rate of $1 a relong. All rent shall be due on the first of Muharram[13] of each year. The premium upon a mining lease shall not be less than $25 a relong. (Rules under the mining enactment 1347.)

All matters relating to the collection of land revenue shall be subject to the land laws of the State for the time being in force. (Art. 23.) (See p. 2 of this paper.)

Office fees and survey fees shall be those prescribed by the land enactment at the time in force, subject to any special instructions by the President of the State Council. (Rules under the mining enactment 1347.)

The fee for an exclusive prospecting license is $25; that for a renewal thereof is $50. (Schedule J.)

Trespasses and Penalties

Penalties for failure to comply with the provisions of the mining enactment and documents issued thereunder range from $100 to $1,000. (Art. 42 to 48.)

Lombong Siam

Underground workings or workings known as "lombong Siam"[14] shall not be legal without a license from the Superintendent of Mines, who may at will grant or refuse such a license, except that a refusal must be accompanied by the reasons therefor. (Art. 35.)

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13 - First month of the Mohammedan year.
14 - See footnote 9.

Dulang Washing

The Superintendent of Mines may issue to any person a license, called a "dulang pass," subject to the conditions stated therein, to wash for tin ore with a dulang (tray or prospecting pan). (Art. 27.) Such a pass may be granted for State land and for alienated land with the permission of the lawful occupier. It is not transferable, and is liable to cancellation at any time. (Schedule K.)

Hydraulicking

The Superintendent of Mines may grant to any person for a period not to exceed 12 months (or for a longer period with the approval of the State Council) a license to work land by ground sluicing or by any method of removing or excavating earth by direct action of water. He has power to stop work when in his opinion damage is being done or may be done by tailings or dams. (Art. 30 to 34 and also rules under the mining enactment 1347.)

Safety Measures

The occupier of land in which any open pit, shaft, or tunnel exists shall maintain all required fencing and shall immediately fill in any unused shaft. He shall, when necessary, securely line and support shafts, tunnels, and other underground passages in order to insure complete safety; and he shall provide the ventilation ordered by the Superintendent. (Rules under the mining enactment 1347.)

Purchase and Storing of Ore

No one except a licensee of the Government has the right (1) to purchase any mineral ore or (2) to keep any house, store, shop, or place for the purpose of purchasing or storing therein any mineral ore other than that raised from land in his own occupation. A license to purchase and store mineral ore may be obtained from the Superintendent of Mines upon the payment of the prescribed fees. (The mineral ore buyers enactment 1346, No. 4 of 1346, November 24, 1927.)

PERLIS[15]

GENERAL

It is assumed, from the nature of the mining leases, that the Government of Perlis claims only those minerals that are found on or beneath State land (including underground streams and caverns) or in rivers, streams, and water courses. The control over and property in all rivers, streams, and water courses are vested solely in the Government, by article 44. Coal, oil, and guano, by their exclusion from the provisions of the mining enactment (by article 3), are State monopolies.

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15 - The only law available for consultation with respect to the State of Perlis is the mining enactment No. 1 of 1340 (6th day of Jamadilakhir 1340), to which the citations in this section refer.

Mining authority is vested in the Raja of Perlis, the State Council, and the Commissioner of Lands and Mines. A mining lease or a mining license is issued under the hand of the Raja, with the approval of the State Council; otherwise prospecting and mining rights are granted by the Commissioner of Lands and Mines, with the consent of the Council. The State Council is vested with the authority to make rules for the execution of the provisions of the enactment, especially with respect to (a) prescribing the powers and duties of officers, (b) changing schedule forms, (c) regulating operations in and about the mines themselves, (d) prescribing fines (not to exceed $500) for infraction of the mining law, and (e) fixing rents and other charges. (Art. 56.)

RIGHTS OF FOREIGNERS

The law neither admits to nor excludes from the mining rights in the State either foreign individuals or foreign companies.

PROSPECTING

Prospecting licenses, either for State land or for caves and underground streams beneath State land, may be issued (upon the payment of the prescribed fees) by the Commissioner with the approval of the State Council, for a period not to exceed 12 months, subject to the terms, conditions, and limitations the Council may see fit to impose. (Art. 22, 23, and 24.)

A license to prospect State land, called an exclusive prospecting license, carries with it the right of the licensee to receive a mining lease for such area as the Council may approve. (Art. 24.)

As long as the holder of a prospecting license for caves and underground streams maintains not less than five coolies doing real prospecting work in any "wang," his license is exclusive in that the State Council does not have the right to grant another license for the same area. (Art. 23.)

The holder of either class of license may remove and export all minerals raised during prospecting operations, upon the payment of the royalty or export duty fixed by law. (Art. 25.)

MINING TITLES

Mining is done under leases for State land and licenses for underground streams and caverns beneath State land, which give the holders thereof the right to remove and export all the minerals and metals found, upon the payment of the royalty due the State. They are granted for any period under 21 years that the Council may direct. Any lessee or licensee desiring to obtain a renewal shall make written application to the Commissioner at least 12 months before the expiration of the original document. Renewals are issued by the Commissioner, with the approval of the Council of State. (Art. 14, 15, 19, 20, and 58.)

An application for a mining lease to work State land shall be made to the Commissioner. It shall set forth the boundaries and the approximate area of the land desired. If the application is approved by the State Council, permanent marks shall be erected, and the land shall be surveyed, the costs thereof to be paid by the applicant within one month of the notice of approval. (Art. 5 to 10.)

Should the applicant desire to commence work before the completion of the survey, the Commissioner, with the approval of the Council, may issue a temporary lease (mining certificate), subject to the same conditions as a lease and to be exchanged therefor. (Art. 11.)

The procedure necessary to obtain a license to mine in a cavern or underground stream is practically the same as that required to secure a lease for State land. The applicant must cause the entrance to the cavern to be conspicuously marked and must submit a plan showing the position of the entrance with reference to a survey point. (Art. 16 to 18.)

Leases and Licenses

Area.--A mining lease covers an estimated number of relongs in a described area; a license covers the caves and streams in a described area. (Schedules 6 and 7.)

A licensee of caves and underground streams is given the right to work beyond the approved area in following any cavern or stream to which he has gained natural entrance within the area, provided that he shall not infringe upon the rights of any other licensee or lessee. However, no licensee shall have the right to work any surface or open stream even when access thereto has been gained by lawfully following a cavern or underground stream. Disputes arising as to rights on the surface and underground granted by mining titles shall be settled by the State Council. (Art. 20, 21, and 28.)

Work required.--Bona fide mining operations shall be commenced within six months from the date of the lease or the license. Thereafter a lessee shall employ at least one coolie for every 2 relongs of land and a licensee shall employ 10 coolies. (One horsepower of machinery or plant shall be equal to eight coolies.) Thereafter a licensee or lessee shall not fail for a period of more than six consecutive months to carry on mining operations and to keep at work the specified number of coolies. All operations must be conducted in an orderly, skillful, and workmanlike manner and without danger or damage to others. (Art. 28.)

Rights and obligations.--In addition to rights stated or implied in preceding paragraphs, licensees and lessees in Perlis are subject to the same rights as those in Johore and Kedah, with respect to the use of land for auxiliary purposes and to the use of timber and jungle produce (art. 15 and 20), and likewise to the same obligations, with respect to (a) payment of rent and fees, (b) preservation of boundary lines and marks, (c) permitting free access by Government officials to mines and buildings, (d) allowing the

removal by the Government of road and building materials, (f) permitting access to adjoining lands, (g) posting names of lessees or licensees, and (h) exhibiting lists, known as "kong-pai," of the coolies employed. (Art. 28.)

Transfer.--Land held under a mining title may be transferred, subleased, or mortgaged, under the provisions of articles 34 to 37.

Surrender.--As under the laws of Johore and Kedah, mining rights held by a lease, certificate, or license may be voluntarily surrendered, provided all sums due the Government thereon have been paid; the Commissioner is not bound to accept the surrender of land that is subject to any incumbrance or of land with respect to which the provisions of the enactment have not been fulfilled. (Art. 39 to 42.)

Forfeiture.--If the holder of a mining right (lease or license) fails to pay the prescribed rent under a lease or the fees under a license, to commence work within the required time, to employ the specified number of coolies, or to comply with any of the special conditions of his document of title for which no other penalty is provided, and continues in such breach, his lease or license shall be liable to forfeiture. (Art. 30.)

If after the required summons to show cause why, the licensee or the lessee fails to prove his case, the Commissioner, with the approval of the State Council, shall serve a notice of forfeiture. (Art. 31 and 32.)

MISCELLANEOUS

Dulang pass.--Individual passes to wash for tin ore with a dulang only, in streams or in abandoned mines on State land, for a prescribed period and fee, may be issued to women and to children under 16 years of age by the Commissioner. A dulang pass must be carried on the person of the holder, to be produced whenever required by an official of the Government. (Art. 26.)

Lombong Siam.--No working known as "lombong Siam" shall be carried on upon any land without the sanction of the Council of State. (Art. 49.)

Deposit of tailings.--Overburden and tailings shall not be deposited on unworked land without the sanction of the State Council, except so far as it may be necessary in the opening of a mine. (Art. 28 and 46.)

Prevention of water pollution.--Every person using water in connection with mining operations shall insure its purity before it leaves the mining area. For a breach of this regulation, the State Council may cause a cessation of operations and for failure to rectify the breach may render the land forfeited. (Art. 47 and 48.)

Trespasses and penalties.--For any breach of the mining enactments to which no specific penalty is attached, the fine shall not exceed $200 or the penalty three months in prison. (Art. 55.)

Any person prospecting or mining on land without lawful authority shall be liable to a maximum fine of $500 or imprisonment for not more than six months and to confiscation of implements, buildings, ore, and other products. (Art. 54.)

Any prospecting licensee failing to fill in shafts within one month from the date of expiration of his license is liable to a fine not to exceed $10 for each unfilled shaft. "Lombong Siam" workings are subject to the same conditions. A defaulter at the time of his conviction may be ordered by the court to fill in the shaft within a certain period. Disobedience of the court order makes the defaulter liable to a further maximum fine of $5 a day. The Commissioner may cause all shafts that have not been filled, in accordance with the preceding regulations, to be filled at the expense of the defaulter, costs to be recovered by an order of the civil court, if necessary. (Art. 50 to 52.)

Any manager or person in charge of a mine failing to report loss of life or serious injury occurring in mining operations shall be liable to a maximum fine of $50 or to imprisonment for one month. (Art. 53.)

KELANTAN[16]

GENERAL

With respect to the ownership of the mineral wealth of the State of Kelantan, the land enactment of 1926 says:

> All tin, gold, petroleum, and other minerals are the property of the Government, and no operations to work such minerals shall be carried on upon lands held under agricultural title, except only in such cases as express permission has already been given (art. 4).
>
> Except with the permission of His Highness no mining lease shall be issued for any land that has been alienated for agricultural purposes (art. 5).
>
> All seashores and shores in tidal rivers below high-water mark at ordinary high spring tides are the absolute property of the Government, and all rights of foreshore and accretions are vested in the Government solely (art. 6).

With respect to mining authority, section 12 of the prospecting license form reads:

> The Government means His Highness the Sultan acting on the advice of the British Adviser, but any order or decision of the Government hereunder may be communicated to the licensee by writing under the hand of the British Adviser.

16 All citations referring directly to prospecting and mining are to an official prospecting license form and to Notification No. 27 of 1929, the individual mining license rules, 1929.

Article 30 of the land enactment of 1926 gives the Sultan in Council authority to make rules for effectively carrying out the provisions of the law, especially with respect to the issuing of licenses for any purpose necessary under the enactment; fixing of fees, rents, premiums, etc.; determining the powers and duties of officers; and prescribing or altering any form with respect to land.

RIGHTS OF FOREIGNERS

Article 47 of the land enactment of 1926 reads:

> Notwithstanding anything contained in the above section, it shall be within the power of the district officer or superintendent of lands to refuse registration of any transfer, charge, or lease by a native of Kelantan to a party who is not a native of Kelantan until he is satisfied that such transaction has received the approval of His Highness the Sultan.

The article quoted was repealed by an amending enactment, No. 3 of 1930, which added to the basic land enactment articles 80 to 99, articles 87 to 98 to apply to mine leases, agreements for mine leases, and mining certificates. The new sections placed restrictions upon the sale, etc., of land to aliens or nonnatives (native to include the Government of Kelantan or any public officer acting on behalf thereof).

Later, by enactment No. 18 of 1930 (The Malay Reservations Act), His Highness the Sultan was given the right to declare articles 82 to 86 of the amended land enactment of no effect in any part of the State or to declare them totally repealed (art. 2). The Malay Reservation Act (which defines "Malay" as a person belonging to any Malayan race, who speaks any Malayan language, and who professes the Mohammedan religion) provides:

> That any land, whether State land or land held under permanent or temporary title may be included in any Malay reservation. (Art. 4.)
>
> That no State land included in a Malay reservation shall be sold, leased, or otherwise disposed of, otherwise than by a temporary occupation license for a period not exceeding one year, to any person not being a Malay. (Art. 6.)
>
> That no right or interest of any Malay in reservation land shall be transferred or vested in any person not being a Malay, provided that leases of reservation land shall be valid to the extent specified in subsections (ii) to (v). (Art. 7.)
>
> > (ii) Every document purporting to be a lease or agreement for a lease from a Malay to a person not a Malay of any reservation land not situated within the boundaries of a town declared under the provisions of section 23 of the land enactment of 1926 shall be deemed to be a lease or agreement for a lease from month to month, terminable upon one month's notice on

either side, and any lease or agreement for lease of any such land shall be valid and enforceable according to a lease or agreement for lease from month to month.

(iii) Subject to the approval of the Sultan, in any case, it shall be lawful to register a lease for a period not exceeding three years from a Malay to a person not being a Malay of any land situated within the boundaries of a town declared under section 23 of the land enactment, 1926, and any such lease shall be valid and enforceable, provided that no such lease shall be registered unless the lessee produces to the land officer a certificate signed by the State Secretary in the form of schedule A. Such certificate shall upon registration of the lease be attached to the land office copy of the lease.

(iv) The provisions of subsection (ii) shall apply to all leases (not being leases registered under subsection iii) and to all agreements for leases of land situated within the boundaries of any town declared under section 23 of the land enactment, 1926.

(v) Any term in a lease or agreement for a lease that gives the lessee the right to renew the lease or agreement for lease at the termination thereof shall be null and void.

That no right or interest of any Malay in reservation land shall be sold in execution of a decree or by order of any court or for nonpayment of rent due to the Government to any person not being a Malay. (Art. 9.)

That any question as to whether a person is a Malay or not may be referred through the British Adviser to His Highness, who shall decide the same, and his decision when certified under the hand of the State Secretary shall not be questioned or revised by any court. (Art. 13.)

PROSPECTING[17]

Licenses

A prospecting license, issued by the Superintendent of Lands, on behalf of the Government of Kelantan, with the sanction of the Sultan, acting upon the advice of the British Adviser, carries with it the right to a mining lease, provided the Government is satisfied that the licensee has completed a sufficient amount of prospecting. (Sec. 5.)

A license confers upon the licensee the exclusive right to prospect for all minerals other than mineral oil or oil shales in the area licensed, provided that he shall undertake only such work as may be reasonably necessary to test the mineral content of the land. However, he may remove from the

17 - Prospecting license form, Government of Kelantan.

land and dispose of all minerals raised in prospecting, subject to payment of the export duty which may be in force at the time of exportation. (Sec. 1, 4, and 8.)

Duration and Renewal

The period during which a license may remain in force is stated in the license, and it may be extended if before the date of its expiration the holder thereof shall prove to the Government that sufficient reason exists for his not having completed his work. (Sec. 6.)

Area

A prospecting license covers an estimated number of acres, described and located in a schedule attached to the license and shown on a plan annexed thereto. It excludes all lands that are under any form of mining or agricultural title, license, or permit, whether the licensee shall have had notice of the rights of the holders thereof or not. (Sec. 1.)

Work Required

A licensee shall begin bona fide prospecting within three months from the date of the issuance of the license and shall thereafter carry on such amount as the Government deems reasonable. (Sec. 7.)

Conditions

A licensee shall conduct his prospecting in accordance with such regulations as the Government may from time to time prescribe, shall permit any officer authorized by the Government to inspect his work, and shall submit, whenever so required, to the British Adviser a full and true report of the results of his prospecting. (Sec. 9 and 10.)

Damages

Every licensee shall make due compensation to the owners or occupiers of any land damaged by reason of his prospecting operations and shall indemnify the Government against any claims that may be made against it because of such damage. (Sec. 2.)

Transfer

A prospecting license is not transferable but is transmissible upon the death of the licensee. (Sec. 3.)

Cancellation

The Government may summarily cancel a license for any breach of the mining regulations. (Sec. 11.)

MINING TITLES

Mining Lease[18]

The Government may grant a lease (or leases) or an agreement (or agreements) for mining State land to a prospecting licensee that has completed a satisfactory amount of prospecting.

A successful prospector, within three months of the expiration of his prospecting license, may select within the prospected area the number of acres he desires to mine. Upon the payment of the required premium, and subject to such terms, obligations, and conditions as the Government may prescribe, he may receive a mining lease for the whole or a part of the area selected.

Individual Mining License[19]

The individual mining license rules give the Sultan in Council the right to declare any area an area within which mining under an individual license may be done and make it lawful for any district officer to issue such a license for a designated area within his jurisdiction as long as the declaration remains in force.

An individual mining license (for which a fee of $5 is charged) authorizes only the person named therein to mine, and it does not authorize the extraction of mineral oil and oil shales.

An individual license is valid only up to December 31 of the year in which it is issued. It is not transferable and is liable to immediate cancellation by the district officer for default in the observance of any of the conditions attached thereto or for disregard or disobedience of any lawful order.

An individual license must be carried upon the person of the licensee and must be produced whenever lawfully required.

TRENGGANU[20]

GENERAL

With respect to the State's ownership of minerals, the land enactment No. 5 of 1344, says:

> Every document of title shall under this enactment give rights to the landowners over the surface land only; it gives no authority to remove from within the boundaries of the land any timber or mineral,

18 - See footnote 17.
19 - The individual mining license rules, 1929, notification No. 27 of 1929, Sept. 10, 1929, effective Oct. 1, 1929.
20 - Citations in the section of this paper relating to the State of Trengganu, unless otherwise indicated, are to the principal mining enactment, No. 3 of 1345, which came into effect July 1, 1927.

stones, sand, coal, or other substance, or any commodity manufactured from the said materials, except with special permission carrying Government regulations. No mining operations may be carried on without special written authority. (Art. 10.)

The same enactment says:

Rivers and river beds, streams, water courses, and lands below water mark are all the property of the Government and can not be made the property of private persons; but it shall be within the power of the Commissioner, with the consent of the Government, to authorize occupation under temporary occupation licenses or leases of lands below high-water mark. (Art. 5--1.)

No land within two chains of the seashore or of the bank of any river to which this prohibition has been declared by Government proclamation to apply shall be alienated to any person; but it shall be within the power of the Commissioner to authorize occupation under Government temporary license or with the consent of the Government to grant leases over land included in this subsection. (Art. 5--3.)

His Highness the Sultan in Council may create reserves of land for any approved purpose. So long as the reservation remains in force, the land may not be alienated or used for any purpose other than the purpose approved. Any use thereof contrary to the approved purpose shall be invalid and void. (Art. 6.)

With respect to mining authority, as in the case of most of the other Unfederated Malay States, the Sultan is the nominal chief authority. Every mining lease shall be signed by the Sultan and shall be sealed with the State seal. The Sultan in Council may from time to time make rules for the carrying out of the provisions of the mining enactment, especially with respect to (1) premiums, rent, and fees, (2) statistical and other returns to the Government, (3) fines for offences not already provided for, and (4) all kinds of mining operations. (Art. 5 and 31.)

The Commissioner of Lands is the real mining authority. He may, upon his own responsibility, approve the issue of leases for areas not exceeding 10 acres. (Art. 4.) With respect to transfers of mining land and like matters, the Commissioner of Lands has the powers of the registrar under the land enactment. (Art. 8.) He shall issue instructions to the owner or occupier of mining land with reference to water, explosives, accident prevention, deposit of overburden and tailings, lombong Siam, open pits, machinery, and similar matters. (Art. 27.)

The State Council has the power to declare a lease forfeited (art. 14), to proclaim a district or a river to be an area within which individual mining may be carried on (art. 16), and to act as the final body of appeal in some instances against the decisions of the Commissioner of Land (art. 27).

RIGHTS OF FOREIGNERS

Government proclamation No. 1 of 1337 (A. D. 1918?) prescribed the following rules with respect to foreign individuals or foreign companies desiring to obtain, by grant or transfer, mining or agricultural land:

1. All companies composed of persons who are not Trengganu subjects and all persons who are not Trengganu subjects must first of all produce properly certified proofs showing the acreage of all mining or agricultural land in Trengganu over which they already hold any rights of ownership or control, or showing that they do not own or control any such land.

2. Such companies or persons or their agents are not allowed to obtain by grant or transfer the rights over mining land exceeding a total of 500 acres or agricultural land exceeding a total of 3,000 acres whether in one place or in several places, except in cases which have been approved by the British Government as proper to be allowed with the consent of His Highness the Sultan.

3. Companies or persons as aforesaid, or their agents, who already enjoy the ownership or the control of mining land or agricultural land not less in extent than the acreages above mentioned are not allowed to obtain further land by grant or transfer except with the special approval and consent stated above.

4. If any company not of Trengganu subjects or person not a Trengganu subject obtains by grant or transfer or makes an agreement to obtain by any means any mining land more than 500 acres in extent or any agricultural land more than 3,000 acres in extent after the date of the coming into force of these rules, no deed or agreement relating to such transaction shall be admitted by the Government, and any such deed or agreement shall be void and of no effect.

PROSPECTING

Licenses

A prospecting license shall contain a description of the area to be prospected, its approximate extent, its boundaries, and the name of the mineral to be sought. It carries with it an exclusive prospecting right within the area named and also the right to select land within that area for a mining lease, provided the Government is satisfied with the prospecting done. The license determines the period of its duration and the fee to be paid therefor. (Art. 21 and 23.)

Application

Every application (which must be in writing) for a prospecting license shall be entered in a register in the Commissioner's office; the Commissioner shall refer it, with his recommendations, to the Government. Every application

shall set forth the position, approximate area, and boundaries of the land desired, the minerals to be sought, and the area for which a mining lease is desired. The Commissioner may require any applicant, before the approval of his application, to demarcate the area over which he wishes to obtain a license. (Art. 18 to 20 and 25.)

Transfer

A prospecting license is not itself transferable, but the right to select a mining area from the prospecting area is transferable, with the approval of the Commissioner, upon the payment of the proper stamp fees. (Art. 21.)

Cancellation

A license may be cancelled at any time if the licensee shall have ceased entirely for three months to work on the land. (Art. 24.)

Filling of Pits

The Commissioner may require a licensee to provide suitable security (not to exceed $500) against the filling of all pits and excavations upon the completion of prospecting. (Art. 26.)

MINING TITLES

Lease

Every mining lease, which shall be granted in the name of the Sultan and under the State seal (art. 5), shall include a description of the land, the area, the annual rent, and the number of coolies to be employed. (Schedule 3.) It shall give the right to the lessee to work and to remove from the land described all minerals found except mineral oil. (Art. 9.)

Every mining lease is subject to the land laws with respect to (a) demarcation and survey, (b) collection of revenue, (c) subdivisions of land, and (d) acquisition of land. (Art. 15.) (See p. 4 of this paper.)

Application

An application for a mining lease, to be filed with the Commissioner of Lands (art. 3) shall name the mineral to be won, shall contain a complete description of the land to be leased, and shall be accompanied by a plan (on the scale recommended), showing all rivers and streams nearby and all bearings of all boundaries, if possible. It shall be accompanied by the prescribed fee. (Schedule 2.)

Should an applicant desire to commence mining before the survey can be made, the Commissioner may issue a provisional lease (mining certificate) under the same conditions as the permanent lease and to be exchanged therefor. (Art. 6.)

Duration

No definite period is prescribed in the law for the duration of a mining lease, the period being fixed for each separate document. However, the land enactment (No. 5 of 1344) says:

> His Highness may on special consideration authorize the alienation of any Government land under lease for a term not exceeding 60 years . . . .

Work Required

Bona-fide mining shall be begun within six months from the date of the lease; within one year from the same date there shall be at work on the land not less than the number of coolies mentioned in the lease, which shall not be less than one coolie to an acre. (One horsepower shall be equivalent to eight coolies.) (Art. 10 and 12.) Thereafter the lessee shall not during the term of his lease fail for a period of more than 12 consecutive months efficiently to carry on mining operations or to keep at work less than the prescribed number of coolies. The lessee shall carry on all operations in an orderly, skillful, and workmanlike manner, without danger or damage to the owners or occupiers of other lands or to State lands. (Art. 10.)

Rights and Obligations

In addition to the rights stated or implied in preceding paragraphs, a lessee has the right (a) to erect buildings on the leased land and to grow the plants and keep the animals necessary to his mining operations and (b) to fell timber and clear the land but not to remove timber, rotan, or any other jungle produce without the permission of the Commissioner. (Art. 9.)

The obligations implied in a lease, in addition to those already mentioned, include (1) payment of quitrent annually on the first day of Muharram, (2) maintenance of boundary lines, (3) permitting the Government to remove road-making and road-repairing material from the land, (4) allowing access to adjoining land, (5) taking proper precaution for the health and housing of the coolies, and (6) paying the export duty fixed by the Government. If a lessee of an alluvial deposit shall discover a lode, pocket, or similar formation and shall fail to commence work upon it (if so ordered by the Government) within one year of notice so to do, the Government may take back (for reasonable compensation) that part of the land that contains the lode formation. (Art. 10.)

Transfer

Mining leases are transferable, and all transactions relating to transfers, charges, subleases, caveats, and similar matters fall under the provisions of the land enactment (No. 5 of 1344), in articles 38 to 43. The forms for such transactions are included in schedules 5, 6, and 7, of the mining enactment. (Art. 8.)

Forfeiture

A lease is forfeitable for a breach of the conditions thereof. If within two months from the date of the service of a notice, the lessee fails to show cause why the lease should not be forfeited, the State Council may cancel the lease and return the land to the State. (Art. 14.)

Individual License

A personal, nontransferable license may be issued by the Collector, with the approval of the Commissioner of Lands, upon the payment of monthly fees, for mining in any district or river that may have been declared by the State Council to be an area within which individual mining may be done. The license must be carried upon the person of the licensee and shown to any Government official, upon request. (Art. 16 and 17.)

MISCELLANEOUS

Trespasses and Penalties

Disobedience of the instruction of the Commissioner of Lands with respect to water, explosives, and like matters carries a penalty of $1,000, together with liability to make good all loss or damage caused by the breach. Appeal against the fine may be made to the State Council, whose decision is final. (Art. 27 and 30.)

The penalty for default of the conditions of mining leases and prospecting licenses is $250, at most, for the first offense, together with liability for loss or damage caused by the breach. The maximum penalty for carrying on mining operations on land not authorized or in violation of the mining enactment is $1,000, together with forfeiture of machinery, plant, etc. Prosecutions for these offenses shall be instituted on the authority of the Commissioner of Lands and shall be before the Supreme Court. (Art. 28, 29, and 30.)

The penalty for lampanning or dulang washing on land not comprised within a mining lease without a license shall not be more than $50 or imprisonment for two months for the first offense. (Art. 17.)

Purchase and Sale of Minerals

An enactment with respect to the purchase and sale of minerals and forest product[21] affects indirectly the holders of mining land, although paragraph 1 states that the regulations do not apply to the owners of mines with respect to the minerals won therefrom.

Both the purchase and the exportation of minerals are forbidden to any person not in possession of a buyer's license from the Land Office (the fee for which is $10). Likewise, selling to a nonlicensed person is forbidden; offenders against these provisions are liable to a fine not to exceed $500 or imprisonment for six months, or both.

21 - Regulations for buying minerals and forest produce, No. 2 of 1342, effective December 24, 1923.

I. C. 6634

June, 1932

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES

SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

MINING LAWS OF GREECE

BY

E. P. YOUNGMAN

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

MINING LAWS OF GREECE[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper is one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the right of American citizens to explore for minerals and to own and operate mines in various foreign countries. This interpretation of the mining laws of Greece was prepared from information furnished by Ralph B. Curren, American assistant commercial attache, Athens, in reply to a questionnaire of the United States Bureau of Mines, transmitted through the courtesy of the commercial laws division of the Bureau of Foreign and Domestic Commerce.

INTRODUCTION

In his report,[3] Mr. Curren states that the source of his information was the Director of Mines of the Greek Ministry of National Economy and the Mining Code of Greece, which was compiled from existing laws in 1929,[4] and which has since been modified by several acts of Parliament.

The history of mining legislation in Greece, up to the year 1920, has been covered in Commerce Reports,[5] as follows:

> The first Greek law covering mines was promulgated in 1861 and was drawn up on the basis of the French law of 1810, according to which mineral deposits were divided into three classes: (a) Mines, as customarily understood; (b) placer mines and diggings; and (c) quarries. This law . . . secured to owners of property the rights of making metallurgical researches and defined the terms upon which

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1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6634."

2 Rare metals and nonmetals division, U. S. Bureau of Mines.

3 Curren, Ralph B., Rights of American Citizens to Explore for Minerals and to Own and Operate Mines in Greece: Spec. Rept. 795, Nov. 16, 1931, Athens, Bur. For. and Dom. Com. file 141533.

4 Richardson, Gardner, Rights of American Citizens to Explore for Minerals and to Own and Operate Mines in Greece: Spec. Rept. 638, Nov. 12, 1928, Bur. For. and Dom. Com. file 77929.

5 Weddell, Alexander W., Greek Laws Regulating Exploitation of Mines: Com. Repts. No. 35, Washington, Feb. 11, 1920, pp. 848-849.

mining should be carried on. The basal legislation has been modified from time to time, until it has now become practically obsolete . . . . Finally in the year 1910, the law Gamma Phi Kappa Delta was promulgated on the basis of the Prussian law of 1867 concerning mines. This law superseded all previous regulations and modified profoundly the previous mining practice in the kingdom.

All references in this circular are to the New Mining Code, unless it is specifically indicated otherwise.

RIGHTS OF FOREIGNERS

Foreigners may prospect for minerals and own and operate mines in Greece upon equal terms with citizens of the country, except with respect to mines located near the frontier sections, for which a special permit from the Advisory Council of Mines is required, in addition to the usual conditions. (Par. 7, art. 7.)[6] Sections decreed to be frontiers are: (a) The Island of Corfu and the adjoining small islands; (b) the Provinces of Janina, Preveza, Florina, Palli, Serres, Drama, the whole of Western Thrace, and the territories of Samos, Chios, Mytilene, and Saloniki.

Incorporation under the laws of Greece is not required. However, according to Weddell,[7] "a foreign company must be recognized in Greece in the issue of a royal decree, according to the law XPA of 1861 and PKA of 1881, because without such recognition it can not protect its rights in Greece nor proceed before the Greek courts nor sell stock in Greece."

CLASSIFICATION

Mineral substances are divided into two classes: (1) The products of quarries and (2) the products of mines. (Par. 1 and 4, art. 1.)

The products of quarries include "stones or earth useful to the arts, buildings, agriculture, or industry . . . as long as they do not constitute minerals, according to the classification of the mining law" (sec. 2, par. 5, art. 1), that is: "marble and all kinds of stones, slate, lithographic stones, dolomites, gypsum, flint, grindstone, millstone, granite, clay, verde antique (ophites), trachyte, basalt, lava, chalk, Santorin earth or puzzolana, travertine (tophus), pebbles, sand, sandstone, and any kind of earth, and similar deposits." Slags and residues from ancient operations are included in the products from quarries. Ores of the metals and certain other minerals are classed as "mine products."

6 Made part of the Mining Code by the Decree of Oct. 28, 1929, Official Gazette No. 397, Nov. 11, 1929.

7 Weddell, Alexander W., Work cited.

A second classification is implied, as the State reserves certain minerals and controls others through the issue of permits and concessions (but allows no separation of quarry products from the surface rights). (Par. 1, art. 1; par 1, art. 25.)

OWNERSHIP

With a few exceptions, the State has the right only of disposition of minerals through the granting of prospecting permits and decrees of concession. (Art. 19 of the Constitution.) The State reserves to itself gold in the native state, platinum, etc., emery, mineral cooking salt with all its by-salts, and silver ore (barytine) on the Islands of Milo (Melos), Kimolos, and Polyalgos. Exception is made, also, of all oil-bearing strata, but not of those containing solid hydrocarbons. (Par. 2, 3, and 7, art. 1.) The State reserves also the right of exploiting any mineral deposits in certain districts of the new Provinces, or New Greece (Macedonia, Western Thrace, Epirus, Crete, Mytilene, Chios, and Samos), these mines having been proclaimed national property by a special law. The right to exploit these mines is given to contractors under long-term lease or by adjudications made by the Secretary of National Economy, either upon specified conditions or under contracts approved by the legislature. In the case of an adjudication, open bids may be asked for.

The products of quarries belong absolutely to the surface owner; all other mineral substances are disposed of by the State. Prospecting permits and concession decrees are required. The landowner has the right to prospect upon his own property, provided that no other person has obtained a prospecting permit or a mining concession therefor; but in order to acquire an exclusive prospecting right, even he must obtain a permit from the Government. (Art. 6.)

The State does not claim royalty or rent from conceded areas, but it does collect from State mines the exploitation of which is granted either through adjudication or through a special agreement ratified by law. Under adjudications the percentage is fixed in the specifications.

MONOPOLIES

The Government of Greece does not grant monopolistic mineral concessions; but certain monopolies (mainly upon the distribution or sale of minerals) do exist in the interest of the State. The emery quarries of Naxos have been specifically exempted from the operation of the laws concerning mines;[8] and the sale and distribution of the products of the Naxos quarries have been regulated by a law passed in April of 1923. Other State monopolies include the sale of salt and petroleum. According to Plitt,[9] however, abolition of the petroleum monopoly was favored by the Minister of

8 Weddell, Alexander W., Work cited.

9 Plitt, Edwin A., Review of Commerce and Industries: Consular Rept.9187, Athens, Oct. 20, 1930, Bureau of Mines foreign file 9121.

Finance, but the agreement of the International Financial Control Commission and the approval of the Government has not been obtained. Gypsum and millstone from Melos are also the subjects of monopolies.

PROSPECTING PERMITS

Prospecting permits are required; and they are issued, by the prefect of the Province in which exploring is to be done, to the first legally qualified applicant. The prefect must grant the permit within one month after the receipt of the report from the Inspector of Mines to the effect that the area sought is free -- that is, that no previous application is pending or has been granted. No technical qualifications are required.

A prospector has exclusive rights within his claim to search for any other than the reserved minerals. (Par. 2, 3, and 7, art. 1.) He has the right to remove and sell all minerals obtained by prospecting, as he is considered to be the legal owner of the area. (Art. 2; par. 8, art. 4; par. 7, art. 7; art. 9, 13, and 14.)

Application. - An application for a prospecting permit (which is filed with the prefect of the Province) must set forth the boundaries of the area in question and must be accompanied by a Treasury receipt for Drs.[10] 2,800. Within three months of the service of the application, a trignometrical plan, on the scale of 1/10,000, of the area in question must be submitted. (Art. 4.)

Area. - The area under a prospecting permit shall not exceed 10,000 stremmata.[11] One prospector may, however, be granted several permits. (Par. 1, art. 4.)

Duration. - A permit is issued for two years, with the right of renewal for one year, upon the advice of the Inspector of Mines. (Par. 1, art. 8.)

Restricted areas. - Prospecting permits are denied absolutely for public squares, streets, areas used by railways, cemeteries, or areas of public utility; prospecting is not permitted within 60 meters of any residence and its adjoining yards or gardens. The authorities may for adequate reasons refuse the granting of permits for areas of archeological or other public interest. An appeal from such a refusal may be taken to the Minister of National Economy. (Art. 7.)

Fees. - A treasury receipt for Drs. 2,800 must accompany the petition for a prospecting permit, and a receipt for Drs. 70 must accompany the application for the extension of a permit. Three months from the granting of a permit, a treasury receipt for Drs. 280, as a State's fee, must be paid.[12]

10 The value of the drachma in 1930 in U.S. currency was 1.2959 cents. The plural is drachmai.
11 One stremma equals 0.247 acre.
12 Par. 2, art. 4; par. 3, art. 8; par. 1, art. 11; par. 1, 4, and 5, art. 12; par. 1 and 2, art. 91; art. 19 of the Constitution; and Law Gamma Lambda Nu Alpha, of 1911.

Compensation and indemnity. - As a guarantee in favor of the owner of the surface land, an amount varying from Drs. 200 to 1,000 must be submitted within three months of the publication of a permit, - the deposit to be returned if at the termination of prospecting no damages shall have been caused. A surface owner has the right to halt a prospector until compensation shall have been paid for damages to property or for decrease in the usual income therefrom. When property is adversely and permanently affected, the landowner is entitled to indeminfication.[13]

In the absence of an amicable agreement with respect to the value of the occupied area or of the amount of income derivable therefrom, the prospector may request the court to settle the controversy, upon the advice of the Inspector of Mines. When the amount of the indemnity has been determined by the presiding judge and has been deposited in the public treasury, the prospector may enter the area in question for prospecting purposes.[14]

Priority right to a concession. - A prospecting permit gives to the permittee priority right to a mining concession, upon the following conditions: (1) That he has carried out the prospecting within the specified time; (2) that he has submitted an application for a concession within two years (or three years in case of an extension of the permit); and (3) that he has fulfilled all obligations with respect to publications and like formalities required by the law under penalty of annulment.

Work required. - No specified amount of work is required to keep a permit in force; but if a prospector desires to acquire mining rights, he must carry prospecting to a point necessary to prove the existence of minerals and must make application to the prefect for a concession before the expiration of the permit.

CONCESSIONS

A mining concession is granted through a presidential decree. However, with respect to areas reserved to the State, areas containing petroleum, and areas containing precious metals, an agreement with the Government is necessary before mining may be carried on. An agreement is obtained through the Minister of National Economy, after an adjudication has been held.

Application. - An application for a mining concession, which must be submitted to the prefect of the Province in which the mine is located three months before the expiration of the prospecting permit, must be accompanied by:

13 See footnote 12.
14 See footnote 12

1. Four copies of a trignometrical plan of the area in question (on a scale of 1/10,000).

2. Ten okes[15] of the mineral found.

3. A chemical analysis of the mineral.

4. An official report, describing the prospecting works.

5. A plan of the prospecting works (on a scale of 1/100).

6. A treasury receipt for Drs. 1,000, for inspection fees.

The application and supplementary documents are submitted by the prefect to the Inspector of Mines, who orders an examination of the mine works to be made. The inspector's report is followed by the prefect's proclamation, which is published in two newspapers (at the expense of the applicant). The complete file in the case is then sent to the Minister of National Economy, who in three months must obtain a signed presidential decree, which is published in the Official Gazette.

From the time of the registration of the decree (which must be within three months from its publication) with the county registrar of deeds, the applicant becomes the exclusive owner of the mine.[16]

Fees. - A concessionaire must, within three months of the publication of the decree of concession, pay Drs. 700 into the public treasury, under penalty of annulment. The registration fee is Drs. 2,800.[17]

Area. - The maximum area granted by each presidential decree is 10,000 stremmata, but an unlimited number of concessions may be issued to one person.

Duration. - Mines are granted in perpetual ownership.

Work required. - A concessionaire must begin exploitation at the time the concession is decreed and must continue operations regularly upon scientific principles. Suspension of work is justified only when the mine is exhausted, when minerals are found to be poor, when a decline in price renders operations unprofitable, or when factors beyond the control of the concessionaire make exploitation temporarily impracticable. (See also section of this paper entitled "Revocation.")

Land taxes. - An annual land tax must be paid by each concessionaire: Drs. 500 for an area of 1,000 stremmata; Drs. 1,000 for 1,000 to 10,000 stremmata; Drs. 2,000 for 10,000 to 20,000 stremmata; and Drs. 3,000 for 20,000 stremmata or more.

15 One oke equals 2.82 pounds.
16 Art. 10, 15, 16, 20, and 24.
17 See footnote 16.

The land tax is doubled when no minerals have been extracted during the year and is increased "40 per cent for the forced loans tax."

Revocation. - A mining concession may be revoked or annulled under the following conditions:

1. For failure on the part of the concessionaire to register with the county registrar of deeds the concession decree within three months from the date of its publication.

2. Failure to submit the registration fee of Drs. 2,800 or the treasury receipt for Drs. 700.

3. Failure to pay for 3 successive years the required land taxes.

4. Failure to begin mining operations at the time of the granting of the concession and to continue exploitation regularly upon scientific principles. If for four consecutive years from the issuing of a grant, the mine remains idle or is worked inadequately, in the opinion of the Inspector of Mines, or if work is discontinued for a whole year, the inspector shall demand an explanation of the idleness, inadequacy, or interruption. Should the concessionaire refuse to give an explanation or should his reasons be considered unfounded or unreasonable, he shall be requested to renew mining operations. Should another year of inactivity ensue, the inspector shall report the case to the Minister of National Economy, who shall at his discretion order the revocation of the concession.

Within five months of the date of a revocation, any mortgagee, any claimant upon the mine, or any former owner thereof may request the court of first instance to place the property on public sale. An ex-owner is excluded as a purchaser in such a sale. (Par. 1, art. 30.) If an auction does not take place, the mine is granted to the first applicant in line after the revocation of the concession. (Par. 2, art. 30.)

TRANSFERS

Either a prospecting permit or a mining concession may be transferred (leased, sold, or disposed of through some other form of agreement), but the document of transfer must be signed by a notary public and approved by the Minister of National Economy. The sale or lease of a mine near the frontier must have the unanimous approval of the Mining Advisory Committee.

A tax of 14 per cent of the value of the mine is levied upon a sale; and a tax of 11 per cent of the collected rent, together with a 4 per cent surtax, is levied upon a lease. These taxes are decreased 50 per cent in the case of a sale or a lease to a corporation when a certain number of shares in the company or a percentage of the net profits is promised as remuneration.

APPEALS

Provision is made for appeals against the decisions of mining authorities with respect to the issuing or refusing of permits or concessions and with respect to their revocation.

Granting of Rights

A mining inspector's report, upon which the prefect bases his decision, must state that the area sought has not been previously granted to a prospector or a concessionaire or that a permit should be refused on the ground that all or part of the area coincides with that under a previously issued permit or concession. Within one month after the publication of the prefect's decision in the Official Gazette, an applicant may appeal, or any other person whose interests are affected may take an exception, to the Minister of National Economy. The appeal or the exception will be heard before a special administrative mining court, composed of judges and Government officials, under the chairmanship of the President of the Court of Appeals of Athens. The decision of this administrative court is final and obligatory unless carried to the State Council within two months after its service. (Par. 6 to 8, art. 5.)

If a concession is granted for an area covered by an earlier decree, the first concessionaire always has the right to take his claim to the regular courts (courts of first instance).

Revoking of Rights

A revocatory decision by the Minister of National Economy may be appealed in the court of first instance within a month from the publication of the decision in the Official Gazette. The opinion of the court must be rendered within three months from the date of the appeal. The court's decision is final; and if the findings are in favor of the owner of the mine, the revocation is cancelled; but if the appeal is denied, the revocation becomes definite. (Art. 29.)

MISCELLANEOUS

The general laws for the protection of labor apply to mining enterprises. The 8-hour day is obligatory, especially for workers in galleries or other unsanitary places. Women and minors are not permitted to work in the galleries or to do night work.

A mine owner pays one-half of the accident indemnity allowed to mine workers, and the Miners' Fund furnishes the other half. The owner contributes to such a fund 2 per cent of the wages he pays. A miners' fund must be established for every mine in the interests of the workmen and other employees.

A net-income tax applies to mines. Minerals also are subject to a small county or port tax, which varies according to the district in which the mine is located. Minerals are not subject to export taxes or to sales control, in general. However, on April 3, 1923, a sales control decree was made for the more equitable distribution of the emery ore produced in the Island of Naxos. This law[18] has since been amended.

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18 Lowrie, W. L., Distribution of Naxos Emery Ore by the Greek Government: Consular Rept. 736, Apr. 25, 1923, Dept. of Com. file 96953; Bureau of Mines foreign file 5809.
Lowrie, W. L., Greek Emery Ore Law: Consular Rept., Nov. 16, 1923, Dept. of Com. file 117817; Bureau of Mines foreign file 6428.

I. C. 6635

June, 1932

Department of Commerce

UNITED STATES BUREAU OF MINES
Scott Turner, Director

INFORMATION CIRCULAR

NATURAL-GASOLINE PLANTS IN THE UNITED STATES, JANUARY 1, 1932

BY

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

NATURAL-GASOLINE PLANTS IN THE UNITED STATES, JANUARY 1, 1932[1]

By G. R. Hopkins[2] and E. M. Seeley[3]

INTRODUCTORY SUMMARY

The number of natural-gasoline plants has shown a consistent decline in recent years, but the total capacity has increased steadily. The number of completed plants, as determined by a survey as of January 1, 1932, amounted to 959. Previous surveys of January 1, 1928 and 1930 showed 1,155 and 1,035 plants, respectively. Of the total plants on January 1, 1932, 859 were operating and 100 were shut down, compared with 999 operating and 36 shut down on January 1, 1930. The material gain in the number of inoperative plants in the last two years was probably due to the severe decline in prices of 1931.

The low prices of 1931, which were approximately 40 per cent below 1930, made it virtually impossible for the majority of the independent plants, or plants not owned by a large integrated company, to operate at a profit. Accordingly, the majority of the plants removed from the list in 1930 and 1931 were owned by companies which were engaged solely in the manufacture of natural gasoline.

The total daily capacity of the plants on January 1, 1932, amounted to 11,387,000 gallons, an increase of 871,000 gallons, or 8 per cent, in the two years 1930 and 1931. That the total capacity of the plants has increased while the number of plants has declined is due to the fact that nearly all the plants constructed in the last five years have been large plants.

During 1931 the average total daily capacity of the operating plants was approximately 10,600,000 gallons, while the average daily production amounted to 4,944,000 gallons. This indicates that the plants operated during 1931 at 47 per cent of their capacity, compared with 58 per cent in 1930 and 61 per cent in 1929.

Although more plants have been dismantled in Oklahoma in recent years than in any other State, it continues to rank first in number of plants. On January 1, 1932, there were 238 plants in Oklahoma, compared with 145 plants

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1 The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6635."
2 Economic analyst, U. S. Bureau of Mines.
3 Statistical clerk, U. S. Bureau of Mines.

in California, which ranked second. In total capacity the reverse is true; that is, California, with a total daily capacity of 4,057,000 gallons, ranks first, and Oklahoma, with a total daily capacity of 3,189,000 is second.

There are three common methods of extracting natural gasoline: namely, absorption, compression, and charcoal. The absorption method has shown a rapid growth in relative importance in recent years, although in 1930 and 1931 this growth was much less pronounced than formerly. The compression method has declined steadily in relative importance, although the total daily capacity of the plants using this process has shown only a small decrease in the last four years. The charcoal method, the most recently developed of the three processes, has also declined in relative importance; only 17 of these plants with a total daily capacity of 122,000 gallons were reported on January 1, 1932.

The largest plant listed is that of the Shell Oil Co. of California at Long Beach, Calif. This plant had a rated capacity of 220,000 gallons daily. The largest plant east of California was that of the Sinclair Oil & Gas Co. at Seminole. There were several plants of less than 10 gallons daily capacity in Pennsylvania.

EXPLANATORY NOTES

1. Status:

Op.	Operating on January 1, 1932.
S.d.	Shut down on January 1, 1932.

A complete record of plants building on January 1, 1932, was not obtained; hence such plants were omitted from this list.

2. Location:

Location for States, exclusive of California, is given whenever possible as the nearest town. For California, "location" refers to the crude producing field in or near which the plant is located.

3. Daily capacity:

The capacity given represents the average daily output of the plant in complete operation, expressed in gallons.

4. Type:

Denotes process used at plant, the more common of which are designated as follows:

Abs.	Absorption process
Comp.	Compression process
Char.	Charcoal process
Comb.	Combination of the above-named processes.

RECAPITULATION BY STATES
January 1, 1932

	Number of plants							Capacity per day, thousands of gallons						
	Operating	Shut down	Total	Absorption[1]	Compression	Combination	Charcoal	Operating	Shut down	Total	Absorption[1]	Compression	Combination	Charcoal
Arkansas	13	1	14	8	2	2	2	88	15	103	61	8	25	9
California ...	113	32	145	128	2	15	-	3,784	273	4,057	3,758	13	236	-
Colorado	2	1	3	3	-	-	-	6	6	12	12	-	-	-
Illinois	79	2	81	-	81	-	-	58	1	59	-	59	-	-
Indiana	1	-	1	-	1	-	-	(2)	-	(2)	-	(2)	-	-
Kansas	17	3	20	16	4	-	-	183	20	203	188	15	-	-
Kentucky	7	-	7	4	2	-	1	47	-	47	44	1	-	2
Louisiana	38	12	50	33	10	4	3	410	67	477	413	37	18	9
New Mexico ...	2	-	2	2	-	-	-	80	-	30	80	-	-	-
New York	1	2	3	1	1	1	-	(2)	2	2	2	(2)	(2)	-
Ohio	26	1	27	7	19	-	1	59	(2)	59	50	3	-	6
Oklahoma	216	22	238	128	83	27	-	2,955	234	3,189	2,254	616	319	-
Pennsylvania[3].	119	13	132	24	106	-	2	109	31	140	96	38	-	6
Texas	121	7	128	86	26	15	1	2,354	57	2,411	1,897	232	279	3
West Virginia.	96	4	100	30	59	4	7	364	24	388	224	59	18	87
Wyoming	8	-	8	6	2	-	-	160	-	160	56	104	-	-
	859	100	959	476	398	68	17	10,657	730	11,387	9,135	1,185	945	122

1/ Alaska has one absorption plant, operating, of 130 gallons capacity.
2/ Less than 500.
3/ Vacuum and gas pumps counted under compression.

DETAIL BY STATES

Status	Company	Location	Daily capacity, gallons	Type
	ALASKA			
Op.	Chilkat Oil Co.	Cordova	130	Abs.
	Total	Alaska	130	
	ARKANSAS			
S.d.	Arkansas Natural Gas Co.	Louann	15,000	Abs.
Op.	do.	El Dorado	10,000	Comb.
Op.	Gulf Refg. Co. of La.	do.	4,500	Abs.
Op.	The Henderson Co.	do.	9,000	Abs.
Op.	Imperial Oil & Gas Products Co.	do.	450	Comp.
Op.	Lisbon Gaso. Co.	do.	9,000	Abs.
Op.	do.	do.	10,000	Abs.
Op.	Magnolia Pet. Co.	Kenova	7,160	Comp.
Op.	Rainbow Gaso. Corp.	El Dorado	5,600	Abs.
Op.	Reserve Pet. Co.	Louann	6,000	Abs.
Op.	Simms Oil Co.	Smackover	4,000	Char.
Op.	do.	do.	5,000	Char.
Op.	Standard Oil Co. of La.	do.	2,000	Abs.
Op.	do.	El Dorado	15,000	Comb.
	Total	Arkansas	102,710	
	CALIFORNIA			
S.d.	American Natural Gaso. Corp.	Santa Maria	7,500	Abs.
Op.	Bankline Oil Co.	Long Beach	30,000	Abs.
Op.	Barnsdall Oil Co.	Elwood	65,000	Abs.
S.d.	Belridge Oil Co.	Belridge	5,000	Abs.
Op.	do.	do.	5,000	Abs.
Op.	do.	do.	50,000	Abs.
Op.	do.	Elk Hills	7,000	Abs.
Op.	Brea Canon Oil Co.	Coyote Hills	14,000	Comb.
Op.	Calumet Oil Co.	Ventura	975	Comp.
Op.	Coline Gaso. Co.	Rincon	6,000	Abs.
Op.	do.	Torrance	10,000	Abs.
Op.	Cowan Oil & Refg. Co.	Rosecrans	10,000	Abs.
Op.	Del Rey Oil & Refg. Co.	Playa Del Rey	57,000	Abs.
Op.	Edington Gaso. & Refg. Co.	Inglewood	5,000	Abs.
Op.	O. C. Fields Gaso. Corp.	Huntington Beach	6,000	Abs.
Op.	do.	do.	30,000	Abs.
Op.	do.	Sunset	10,000	Abs.
Op.	Fullerton Oil Co.	Coyote Hills	6,000	Abs.
S.d.	General Pet. Corp. of Calif.	do.	20,000	Abs.
Op.	do.	Rosecrans	70,000	Comb.
Op.	do.	Santa Fe Springs	190,000	Abs.
Op.	do.	Ventura	45,000	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	CALIFORNIA (Cont'd)			
Op.	Geo. F. Getty Gaso. Co.	Seal Beach	6,000	Abs.
Op.	Gilmore-Dabney Gaso. Corp.	Long Beach	30,000	Abs.
Op.	do.	do.	30,000	Abs.
Op.	do.	do.	30,000	Abs.
Op.	Gilmore Gaso. Plant No. 1	do.	30,000	Abs.
Op.	Highway Gaso. Co.	Ventura	15,000	Abs.
S.d.	do.	do.	3,000	Abs.
Op.	Honolulu Oil Corp. (Ltd.)	Midway	30,000	Abs.
Op.	do.	do.	30,000	Abs.
Op.	Lomita Gaso. Co.	Long Beach	40,000	Abs.
Op.	Los Nietos Prod. & Refg. Co.	Kettleman Hills	150,000	Abs.
Op.	Mohawk Pet. Co.	Playa Del Rey	17,000	Abs.
S.d.	North American Oil Consolidated	Midway	2,400	Abs.
Op.	Norwalk Co.	do.	10,000	Abs.
Op.	do.	Santa Fe Springs	100,000	Abs.
Op.	do.	Sunset	6,000	Abs.
Op.	do.	Ventura	4,500	Abs.
S.d.	do.	do.	3,500	Abs.
Op.	Ohio Oil Co.	Playa Del Rey	16,000	Abs.
Op.	Pacific Western Oil Co.	Elwood	25,000	Abs.
S.d.	do.	Inglewood	7,500	Abs.
Op.	do.	Ventura	35,000	Abs.
Op.	Pan California Gaso. Co.	Playa Del Rey	17,500	Abs.
Op.	Pan California Oil Co.	Potrero	4,000	Abs.
Op.	Reservoir Hill Gaso. Co.	Long Beach	28,000	Abs.
Op.	Rice Ranch Oil Co.	Santa Maria	1,000	Abs.
Op.	Rio Grande Oil Co.	Santa Fe Springs	31,000	Abs.
Op.	Ryan & Hackett Co. (Inc.)	Long Beach	3,000	Abs.
Op.	San Clemente Oil Co.	Lawndale	2,500	Abs.
Op.	St. Helens Pet. Co. (Ltd.)	Midway	2,000	Abs.
Op.	do.	Montebello	600	Abs.
S.d.	Shell Oil Co.	Coalinga	4,000	Abs.
Op.	do.	Coyote Hills	40,000	Abs.
Op.	do.	Dominguez	32,000	Abs.
Op.	do.	Inglewood	10,000	Abs.
Op.	do.	Long Beach	220,000	Abs.
Op.	do.	Santa Maria	4,000	Abs.
Op.	do.	Ventura	130,000	Abs.
Op.	Signal Hill Gaso. Co.	Elk Hills	5,000	Comb.
Op.	do.	Huntington Beach	15,000	Comb.
Op.	do.	Long Beach	35,000	Comb.
Op.	do.	do.	35,000	Abs.
S.d.	do.	do.	11,000	Comb.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	CALIFORNIA (Cont'd)			
S.d.	Signal Hill Gaso. Co.	Long Beach	15,000	Comb.
Op.	do.	Rincon	15,000	Comb.
S.d.	do.	Seal Beach	35,000	Comb.
Op.	do.	do.	30,000	Comb.
S.d.	do.	Sunset	3,000	Abs.
S.d.	do.	do.	2,000	Abs.
S.d.	do.	Torrance	2,000	Comb.
Op.	Signal Oil & Gas Co.	Long Beach	20,000	Abs.
Op.	do.	do.	30,000	Abs.
Op.	do.	do.	15,000	Abs.
Op.	do.	do.	15,000	Abs.
Op.	do.	do.	30,000	Abs.
S.d.	do.	Sunset	5,000	Abs.
Op.	Standard Gaso. Co.	Coyote Hills	6,500	Comb.
Op.	do.	do.	20,000	Comb.
Op.	do.	Dominguez	6,755	Comb.
Op.	do.	Elk Hills	6,000	Comb.
S.d.	do.	Huntington Beach	10,000	Abs.
S.d.	do.	do.	10,000	Abs.
Op.	do.	do.	20,000	Abs.
Op.	do.	do.	10,000	Abs.
Op.	do.	do.	20,000	Abs.
S.d.	do.	Inglewood	6,900	Abs.
Op.	do.	do.	7,500	Abs.
Op.	do.	do.	4,500	Abs.
Op.	do.	Kettleman Hills	110,000	Abs.
Op.	do.	do.	140,000	Abs.
	do.	do.		Booster.
Op.	do.	do.	140,000	Abs.
S.d.	do.	Long Beach	7,000	Abs.
Op.	do.	do.	2,500	Abs.
Op.	do.	do.	30,000	Abs.
S.d.	do.	Midway	7,000	Abs.
S.d.	do.	do.	12,000	Abs.
Op.	do.	do.	30,000	Abs.
Op.	do.	do.	30,000	Abs.
Op.	do.	do.	6,000	Abs.
Op.	do.	do.	10,000	Abs.
Op.	do.	do.	15,000	Abs.
	do.	Montebello		Booster
S.d.	do.	Newhall	1,000	Abs.
S.d.	do.	Richfield	5,500	Abs.
Op.	do.	Santa Fe Springs	15,000	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	CALIFORNIA (Cont'd)			
Op.	Standard Gaso. Co.	Santa Fe Springs	46,000	Abs.
Op.	do.	do.	375	Abs.
Op.	do.	do.	45,000	Abs.
	do.	do.		Booster
Op.	do.	Seal Beach	40,000	Abs.
Op.	do.	do.	15,000	Abs.
Op.	do.	Sunset	7,500	Abs.
Op.	do.	Torrance	6,000	Abs.
S.d.	do.	Ventura	12,000	Abs.
Op.	do.	do.	40,000	Abs.
	do.	do.		Booster
Op.	do.	do.	40,000	Abs.
S.d.	do.	Wheeler Ridge	500	Abs.
S.d.	State Gaso. Co.	Seal Beach	12,500	Abs.
S.d.	do.	do.	22,500	Abs.
Op.	do.	do.	25,000	Abs.
Op.	Superior Oil Co.	Kettleman Hills	100,000	Abs.
Op.	do.	Torrance	2,500	Abs.
Op.	The Texas Co.	Huntington Beach	8,000	Abs.
S.d.	do.	Long Beach	10,000	Abs.
S.d.	do.	do.	15,000	Abs.
S.d.	do.	do.	9,000	Abs.
Op.	do.	do.	75,000	Abs.
Op.	do.	do.	15,000	Abs.
Op.	do.	Montebello	2,500	Abs.
S.d.	do.	Rosecrans	4,000	Abs.
Op.	do.	Santa Fe Springs	100,000	Abs.
Op.	do.	Ventura	12,000	Comp.
Op.	do.	do.	2,500	Abs.
Op.	Union Oil Co.	Coyote Hills	22,500	Abs.
Op.	do.	Dominguez	50,000	Abs.
Op.	do.	Richfield	20,000	Abs.
Op.	do.	Rosecrans	27,000	Abs.
Op.	do.	Santa Fe Springs	100,000	Abs.
Op.	do.	Santa Maria	18,000	Abs.
Op.	do.	Ventura	250	Abs.
S.d.	Universal Consolidated Oil Co.	Belridge	2,000	Abs.
Op.	West Coast Refg. Co.	Richfield	50,000	Abs.
Op.	Western Natural Gaso. Corp.	Long Beach	7,500	Abs.
Op.	do.	Kettleman Hills	160,000	Abs.
Op.	Wilshire Oil Co.	Santa Fe Springs	125,000	Abs.
	Total	California	4,057,255	

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	COLORADO			
Op.	Continental Oil Co.	Ft. Collins	1,000	Abs.
Op.	do.	Wellington	5,000	Abs.
S.d.	Mountain States Oil Co.	Barela	6,000	Abs.
	Total	Colorado	12,000	
	ILLINOIS			
Op.	John S. Abbott, et al	Eaton	3,000	Comp.
Op.	American Oil Development Co.	do.	200	Comp.
Op.	do.	Hardinville	50	Comp.
Op.	do.	Robinson	175	Comp.
Op.	Arkansas Natural Gas Co.	do.	2,000	Comp.
S.d.	Associated Producers Co.	Lawrenceville	100	Comp.
Op.	do.	Robinson	1,300	Comp.
Op.	Bell Brothers	Casey	50	Comp.
Op.	do.	do.	50	Comp.
Op.	do.	Robinson	50	Comp.
Op.	do.	do.	50	Comp.
Op.	do.	do.	50	Comp.
Op.	Big Four Oil & Gas Co.	Bridgeport	200	Comp.
Op.	Borough, Breen & Others	Lawrenceville	350	Comp.
Op.	Brenneman & MacDonnell	Oblong	1,500	Comp.
Op.	do.	do.	500	Comp.
Op.	A. Bruner & Co.	Lawrenceville	300	Comp.
Op.	Cheuvront Oil Co.	Robinson	200	Comp.
Op.	Cheuvront & Stranahan Oil Co.	Oblong	200	Comp.
Op.	Dinsmoor Oil Co.	Robinson	200	Comp.
Op.	Chas. S. Grace	Oblong	200	Comp.
Op.	Kewanee Oil & Gas Co.	Oblong)		(Comp.
Op.	do.	do.)		(Comp.
Op.	do.	do.)		(Comp.
Op.	do.	do.)	235	(Comp.
Op.	do.	do.)		(Comp.
Op.	do.	do.)		(Comp.
Op.	do.	do.)		(Comp.
Op.	Liberty Oil & Gas Co.	do.	300	Comp.
Op.	Henry C. Lord	do.	50	Comp.
Op.	Mahutska Oil Co.	Stoy	1,000	Comp.
Op.	Mallory & Crawford	Oblong	50	Comp.
Op.	Niagara Oil Corp.	do.	600	Comp.
Op.	do.	do.	600	Comp.
Op.	do.	do.	600	Comp.
Op.	do.	do.	600	Comp.
Op.	Nolan & Lamberton	do.	150	Comp.
Op.	Ohio Oil Co.	Bridgeport	1,170	Comp.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	ILLINOIS (Cont'd			
Op.	Ohio Oil Co.	Bridgeport	570	Comp.
Op.	do.	do.	570	Comp.
Op.	do.	do.	1,800	Comp.
Op.	do.	do.	1,190	Comp.
Op.	do.	do.	990	Comp.
Op.	do.	do.	1,000	Comp.
Op.	do.	do.	1,050	Comp.
Op.	do.	do.	1,050	Comp.
Op.	do.	do.	350	Comp.
Op.	do.	do.	390	Comp.
Op.	do.	do.	1,400	Comp.
Op.	do.	do.	1,500	Comp.
Op.	do.	do.	1,500	Comp.
Op.	do.	do.	390	Comp.
Op.	do.	do.	1,200	Comp.
Op.	do.	do.	375	Comp.
Op.	do.	do.	1,140	Comp.
Op.	do.	do.	770	Comp.
Op.	do.	do.	400	Comp.
Op.	do.	Casey	1,150	Comp.
Op.	do.	do.	437	Comp.
Op.	do.	do.	124	Comp.
Op.	do.	do.	241	Comp.
Op.	do.	Hardinville	756	Comp.
Op.	do.	do.	100	Comp.
Op.	do.	Lawrenceville	270	Comp.
Op.	do.	do.	500	Comp.
Op.	do.	Oblong	405	Comp.
Op.	do.	do.	242	Comp.
Op.	do.	do.	342	Comp.
Op.	do.	do.	200	Comp.
Op.	do.	do.	310	Comp.
Op.	do.	do.	1,130	Comp.
Op.	do.	Robinson	243	Comp.
S.d.	do.	do.	472	Comp.
Op.	do.	Stoy	310	Comp.
Op.	do.	do.	833	Comp.
Op.	James D. Twoomey	Allendale	3,000	Comp.
Op.	Vacuum Gaso. Co.	Lawrenceville)		(Comp.
Op.	do.	do.)	5,000	(Comp.
Op.	Vincennes Oil & Gas Co.	do.	9,000	Comp.
Op.	S. M. Wilson	Oblong	200	Comp.
Op.	Wiser Oil Co.	do.	10	Comp.
	Total	Illinois	58,990	

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	INDIANA			
Op.	Wiser Oil Co.	Pike Co.	3	Comp.
	Total	Indiana	3	
	KANSAS			
Op.	Barnsdall Oil Co.	Winfield	20,000	Abs.
Op.	Denman Bros.	Sedan	100	Comp.
Op.	Empire Oil & Refg. Co.	Arkansas City	15,000	Abs.
S.d.	do.	Caney	7,000	Abs.
Op.	do.	Eureka	2,500	Abs.
Op.	do.	Madison	4,000	Comp.
Op.	do.	do.	9,000	Abs.
Op.	do.	do.	10,000	Abs.
S.d.	do.	Sallyards	3,000	Abs.
S.d.	do.	Wellington	10,000	Abs.
Op.	do.	Wichita	40,000	Abs.
Op.	Kansas Gaso. Co.	Winfield	5,000	Abs.
Op.	The Kansas Gas & Gaso. Co.	Medicine Lodge	10,000	Abs.
Op.	do.	McPherson	14,000	Abs.
Op.	Phillips Pet. Co.	Madison	8,000	Comp.
Op.	Shell Pet. Corp.	Oxford	14,000	Abs.
Op.	Sinclair Oil & Gas Co.	Kemro	3,000	Comp.
Op.	The Texas Co.	Gordon	6,000	Abs.
Op.	do.	Atlanta	12,400	Abs.
Op.	Washington Development Co.	Wellington	10,000	Abs.
	Total	Kansas	203,000	
	KENTUCKY			
Op.	Columbia Oil & Gaso. Corp.	Catlettsburg	19,000	Abs.
Op.	do.	do.	19,000	Abs.
Op.	do.	Kermit	5,000	Abs.
Op.	Kentucky Pipe Line Co. (Inc.) (Ky.)	Winchester	2,100	Char.
Op.	Petroleum Exploration Co.	Torrent	300	Comp.
Op.	Swiss Oil Corp.	Fixer	1,500	Abs.
Op.	Wiser Oil Co.	---	200	Comp.
	Total	Kentucky	47,100	
	LOUISIANA			
S.d.	Arkansas Natural Gas Co.	Plain Dealing	15,000	Abs.
S.d.	do.	Magenta	500	Comp.
Op.	do.	Shreveport	10,000	Abs.
Op.	do.	Homer	5,000	Comp.
Op.	do.	Magenta	8,000	Abs.
Op.	Carson Carbon Co.	Collinston	485	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	LOUISIANA (Cont'd)			
Op.	Century Carbon Co.	Archibald	6,000	Abs.
Op.	do.	Swartz	2,500	Abs.
S.d.	Coltexo Corp.	Hammock	8,000	Abs.
Op.	Columbian Gaso. Corp.	Alto	31,000	Abs.
Op.	do.	Fairbanks	12,000	Abs.
Op.	do.	Fowler	18,000	Abs.
Op.	do.	Perryville	12,000	Abs.
Op.	do.	Swartz	12,000	Abs.
S.d.	do.	Spyker	8,000	Abs.
Op.	DeSota Gaso. Co.	Naborton	366	Comp.
Op.	Gulf Refg. Co. of La.	Homer	15,000	Abs.
Op.	do.	Mooringsport	8,000	Comp.
Op.	J. Smylie Herkness	Bastrop	1,000	Abs.
Op.	J. M. Huber Co. of La. (Inc.)	Monroe	4,000	Abs.
Op.	Louisiana Oil Refg. Corp.	Cotton Valley	20,000	Abs.
Op.	Magnolia Pet. Co.	Lane	1,200	Comb.
Op.	do.	Gahagan	2,000	Comp.
S.d.	Monroe La. Carbon Co.	Hancock	2,000	Char.
Op.	Ohio Oil Co.	Haynesville	9,354	Abs.
Op.	do.	Treat	10,000	Abs.
Op.	Phillips Pet. Co.	Homer	10,500	Comp.
Op.	Reserve Pet. Co.	Haynesville	3,000	Abs.
Op.	do.	Homer	2,000	Comp.
Op.	Standard Oil Co. of La.	Trees	6,000	Comb.
Op.	do.	Homer	6,000	Comb.
Op.	Stanolind Oil & Gas Co.	Gilliam	5,000	Abs.
S.d.	The Texas Co.	Mooringsport	500	Comp.
Op.	do.	Naborton	4,000	Comp.
Op.	do.	Oil City	4,000	Comp.
Op.	do.	do.	18,800	Abs.
S.d.	United Carbon Co.	Monroe	2,000	Char.
S.d.	do.	do.	5,000	Char.
Op.	do.	do.	4,000	Abs.
S.d.	do.	do.	2,000	Abs.
Op.	do.	Rayville	9,000	Abs.
Op.	Union Gas Products (Inc.)	Monroe	5,000	Comb.
Op.	United Gas Public Service Co.	Alto	50,000	Abs.
S.d.	do.	Bastrop	1,300	Abs.
Op.	do.	Cotton Valley	50,000	Abs.
S.d.	do.	do.	20,000	Abs.
S.d.	do.	Pine Island	3,000	Abs.
Op.	do.	Sarepta	12,000	Abs.
Op.	do.	Sugar Creek	30,000	Abs.
Op.	do.	Swartz	2,500	Abs.
	Total	Louisiana	477,005	

DETAIL BY STATES—Continued

Status	Company	Location	Daily capacity, gallons	Type
	NEW MEXICO			
Op.	Phillips Pet. Co.	Hobbs	50,000	Abs.
Op.	Shell Pet. Corp.	do.	30,000	Abs.
	Total	New Mexico	80,000	
	NEW YORK			
Op.	Empire Gas & Fuel Co. (Ltd.)	Andover	200	Comb.
S.d.	Producers Gas Co.	Bolivar	1,500	Abs.
S.d.	Wirt Gaso. Co.	Richburg	500	Comp.
	Total	New York	2,200	
	OHIO			
Op.	American Oil Development Co.	Fly	400	Comp.
Op.	do.	New Matamoras	150	Comp.
Op.	Columbia Gas & Elec. Corp.	Berne	2,000	Abs.
Op.	do.	Gore	2,000	Abs.
Op.	do.	Homer	20,000	Abs.
Op.	do.	Pavonia	15,000	Abs.
Op.	do.	Pomeroy	2,000	Abs.
Op.	do.	Sugar Grove	8,000	Abs.
Op.	Hope Construction & Refg. Co.	New Matamoras	200	Comp.
Op.	do.	Fly	300	Comp.
Op.	do.	do.	300	Comp.
Op.	do.	New Matamoras	1,200	Abs.
Op.	Jefferson Gaso. Co.	Rayland	54	Comp.
Op.	Mrs. Jennie Norris	--	100	Comp.
S.d.	North Fork Oil Co.	Newark	100	Comp.
Op.	Ohio Oil Co.	Steubenville	50	Comp.
Op.	Ohio Producing & Refg. Co.	Doylestown	6,000	Char.
Op.	Pure Oil Co.	Fly	150	Comp.
Op.	do.	Newport	100	Comp.
Op.	Reno Oil Co.	New Matamoras	100	Comp.
Op.	Southern Oil Co.	Schley	150	Comp.
Op.	do.	Sycamore Valley	50	Comp.
Op.	Sylvania Prod. Co.	Woodsfield	120	Comp.
Op.	Tuel & Thoenen	New Matamoras	300	Comp.
Op.	do.	Fly	150	Comp.
Op.	do.	do.	200	Comp.
Op.	Tyler Oil Co.	Antioch	160	Comp.
	Total	Ohio	59,334	
	OKLAHOMA			
S.d.	Amerada Pet. Corp.	Ardmore	1,500	Abs.
Op.	do.	Healdton	6,000	Abs.
Op.	do.	Okmulgee	1,500	Comp.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	OKLAHOMA (Cont'd			
Op.	Amerada Pet. Corp.	Earlsboro	15,000	Abs.
Op.	do.	Maud	15,000	Abs.
Op.	do.	Seminole	10,000	Abs.
Op.	do.	Oklahoma City	3,000	Abs.
Op.	Arthur Oil Co.	Sapulpa	1,000	Comp.
S.d.	W. S. Babson	Bowlegs	10,000	Comp.
Op.	do.	do.	4,000	Comp.
S.d.	do.	Snowmac	35,000	Abs.
S.d.	do.	do.	10,000	Comp.
Op.	Barco Gaso. Co.	Wirt	2,000	Comp.
Op.	Barnsdall Oil Co.	Avant	2,500	Abs.
Op.	do.	Beggs	3,000	Comp.
Op.	do.	do.	6,000	Abs.
Op.	do.	Earlsboro	35,000	Abs.
Op.	do.	do.	45,000	Abs.
Op.	do.	Osage	3,500	Abs.
Op.	do.	Turley	2,500	Abs.
Op.	Barnsdall Refineries (Inc.)	Barnsdall	5,000	Abs.
Op.	Bartlett Gaso. Co.	Butler	12,500	Abs.
Op.	Absalom Brown	Haskell	75	Comp.
Op.	Carter Oil Co.	Burbank	22,000	Abs.
Op.	do.	Cromwell	22,000	Abs.
Op.	do.	Hewitt	10,000	Abs.
Op.	do.	Seminole	60,000	Abs.
S.d.	do.	do.	52,000	Abs.
Op.	do.	do.	50,000	Abs.
Op.	do.	do.	50,000	Abs.
Op.	do.	do.	15,000	Abs.
Op.	Central States Prod. Corp.	Wetumka	5,000	Abs.
Op.	Chase Gaso. Co.	Muskogee	1,000	Comp.
Op.	do.	do.	1,000	Comp.
Op.	Coline Gaso. Co.	Oklahoma City	40,000	Comb.
S.d.	J. S. Cosden (Inc.)	Lovell	30,000	Abs.
Op.	Cromwell-Franklin Oil Co.	Oklahoma City	24,000	Abs.
S.d.	Crosbie & Moran (Inc.)	Earlsboro	15,000	Abs.
S.d.	do.	do.	15,000	Abs.
Op.	do.	Konawa	20,000	Abs.
Op.	do.	Lovell	10,000	Comb.
Op.	do.	Okemah	20,000	Abs.
Op.	do.	St. Louis	20,000	Abs.
Op.	Crosbie, Porter & Martin (Inc.)	Okemah	15,000	Comb.
Op.	do.	do.	8,000	Comp.
Op.	Deep Rock Oil Corp.	Cushing	4,000	Abs.
Op.	do.	Kellyville	4,000	Comp.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	OKLAHOMA (Cont'd			
Op.	Deep Rock Oil Corp.	Mehan	12,000	Abs.
Op.	do.	Shamrock	6,000	Abs.
S.d.	do.	do.	4,000	Comp.
Op.	DeSota Gaso. Co.	Muskogee	366	Comp.
Op.	Devonian Oil Co.	Kellyville	15,000	Comb.
S.d.	do.	Tabler	3,000	Abs.
S.d.	do.	Stroud	10,000	Abs.
Op.	Eagle Gaso. Co.	Bristow	400	Comp.
Op.	do.	Sapulpa	900	Comp.
Op.	Eagle Picher Lead Co.	Henryette	5,000	Abs.
Op.	Empire Oil & Refg. Co.	Asher	25,000	Abs.
Op.	do.	Barnsdall	20,000	Abs.
S.d.	do.	Konowa	6,000	Abs.
Op.	do.	do.	14,000	Abs.
Op.	do.	Lima	25,000	Comb.
Op.	do.	Maud	25,000	Comp.
S.d.	do.	Okemah	5,000	Abs.
Op.	do.	Seminole	25,000	Abs.
Op.	do.	do.	20,000	Abs.
Op.	Gas Products Co.	Holdenville	1,000	Comp.
Op.	Chas. W. & Otha H. Grimes	Weleetka	6,000	Abs.
Op.	Globe Gaso. Co.	Blackwell	2,500	Abs.
Op.	do.	do.	2,500	Abs.
S.d.	do.	do.	2,500	Abs.
Op.	Otha H. & Philo Grimes	Weleetka	5,000	Comp.
Op.	Grimes Gaso. Co.	Keystone	8,000	Abs.
Op.	do.	Okemah	10,000	Abs.
Op.	Gypsy Oil Co.	Bristow	2,263	Abs.
Op.	do.	Cleveland	3,087	Comp.
S.d.	do.	Davenport	1,700	Abs.
Op.	do.	Drumright	4,212	Comp.
Op.	do.	Kiefer	14,936	Comp.
Op.	do.	Little River	34,809	Abs.
Op.	do.	Seminole	13,001	Abs.
Op.	do.	Shamrock	2,948	Comp.
Op.	do.	Three Sands	5,210	Abs.
Op.	do.	Webb City	17,198	Abs.
Op.	Harland Oil Co.	Barnsdall	2,000	Abs.
Op.	Highway Oil Refg. Corp.	Tulsa	500	Comp.
Op.	Indian Territory Illum. Oil Co.	Oklahoma City	25,000	Abs.
Op.	do.	do.	25,000	Abs.
Op.	do.	do.	25,000	Abs.
Op.	do.	do.	25,000	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	OKLAHOMA (Cont'd)			
Op.	Indian Territory Illum. Oil Co.	Oklahoma City	25,000	Abs.
Op.	do.	do.	25,000	Abs.
Op.	Indian Territory Illum. Oil Co. & Norwood Oil Co.	Barnsdall	3,000	Abs.
Op.	M. E. James, Tr.	Blackwell	10,000	Abs.
Op.	do.	Ripley	10,000	Abs.
Op.	Lone Star Gas Co.	Hollis	10,000	Abs.
Op.	Magnolia Pet. Corp.	Duncan	562	Comb.
Op.	do.	Davenport	3,848	Comb.
Op.	do.	Earlsboro	6,354	Comb.
Op.	do.	Oilton	9,246	Comp.
Op.	do.	Pearson	9,359	Comp.
Op.	do.	Quay	3,870	Comp.
Op.	do.	Shamrock	7,798	Comb.
Op.	do.	Wewoka	3,950	Comp.
Op.	do.	Wirt	1,346	Comb.
Op.	do.	do.	4,340	Comp.
Op.	do.	do.	1,300	Comp.
Op.	Masoneal Gaso. Co.	Osage	2,000	Comp.
Op.	Mid Kansas Oil & Gas Co.	Bristow	10,000	Comb.
Op.	Mid Continent Pet. Corp.	Cromwell	35,000	Comb.
Op.	do.	Garber	10,000	Comb.
Op.	do.	Leonard	1,000	Comp.
Op.	do.	Morris	5,000	Comb.
Op.	do.	Shamrock	12,000	Comb.
Op.	do.	Stone Bluff	2,500	Comp.
Op.	do.	Stroud	2,500	Abs.
Op.	do.	Tulsa	1,500	Abs.
Op.	do.	Wewoka	3,000	Abs.
Op.	Midco Oil Corp.	Billings	20,000	Comp.
Op.	do.	Denver	10,000	Comp.
Op.	do.	Drumright	5,000	Comp.
Op.	do.	Oilton	10,000	Comp.
Op.	Moon Gaso. Co.	Glenpool	1,200	Comp.
Op.	do.	Muskogee	800	Comp.
Op.	National Products Co.	Cleveland	1,600	Abs.
Op.	do.	Oilton	1,600	Abs.
Op.	do.	Slick	1,200	Abs.
Op.	do.	Terlton	1,600	Abs.
Op.	Neal Gaso. Co.	East Osage	3,500	Abs.
Op.	do.	S. Copan	1,500	Abs.
Op.	Oakhurst Gaso. Co.	W. Tulsa	600	Abs.
Op.	Oil State Gaso. Co.	Jenks	4,000	Comp.
Op.	do.	Yale	3,500	Comb.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	OKLAHOMA (Cont'd)			
Op.	Oklahoma Gaso. Plants (Inc.)	Oilton	8,000	Comb.
Op.	Oklahoma Power & Water Co.	Sand Springs	800	Abs.
Op.	Orfic Gaso. Prod. Co.	Cleveland	2,500	Comp.
Op.	do.	Jennings	2,500	Abs.
Op.	Paraffin Oil Co.	Wann	50	Comp.
Op.	Peppers Gaso. Co.	N. Covington	5,000	Abs.
Op.	Phillips Pet. Co.	Bartlesville	5,000	Abs.
Op.	do.	Bryant	17,000	Abs.
Op.	do.	Cromwell	37,500	Abs.
Op.	do.	De Noya	45,000	Abs.
Op.	do.	do.	42,000	Abs.
Op.	do.	Lyman	42,000	Abs.
Op.	do.	Pershing	14,000	Abs.
Op.	do.	Oklahoma City	60,000	Abs.
Op.	do.	do.	90,000	Abs.
Op.	do.	Seminole	10,000	Comp.
Op.	do.	do.	15,000	Comp.
Op.	do.	Wewoka	40,000	Abs.
Op.	do.	Wetumka	50,000	Abs.
Op.	Pioneer Corp.	Kiefer	8,500	Comb.
Op.	M. F. Powers	Depew	3,000	Abs.
Op.	do.	Hazel	3,000	Comp.
Op.	Powers & Quinlan	Battle	700	Comp.
Op.	do.	Laden	900	Comp.
Op.	do.	Peaster	1,500	Comp.
Op.	Pure Oil Co.	Depew	6,000	Comp.
Op.	do.	Drumright	30,000	Comp.
Op.	do.	Healdton	5,000	Comp.
Op.	do.	Oilton	22,500	Comp.
Op.	do.	Seminole	20,000	Comp.
Op.	do.	do.	15,000	Comp.
Op.	do.	do.	10,000	Comp.
Op.	Reserve Pet. Co.	Barnsdall	2,000	Abs.
S.d.	do.	Shamrock	10,000	Abs.
Op.	Sand Springs Home	Oilton	3,000	Comp.
Op.	Shell Pet. Co.	Blackwell	11,800	Comb.
Op.	do.	Drumright	3,500	Abs.
Op.	do.	Marshall	28,000	Abs.
Op.	do.	Mission	20,000	Abs.
Op.	do.	Oklahoma City	10,000	Abs.
Op.	do.	Tonkawa	25,000	Abs.
S.d.	Signal Oil & Gas Co. (Inc.)	Bristow	5,000	Abs.
Op.	Silurian Oil Co.	Avant	1,500	Comp.
S.d.	Simms Oil Co.	Asher	2,000	Comp.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	OKLAHOMA (Cont'd			
Op.	Sinclair Oil & Gas Co.	Cleveland	6,000	Comp.
Op.	do.	Covington	40,000	Abs.
Op.	do.	Cromwell	15,000	Comp.
Op.	do.	Drumright	7,500	Comp.
Op.	do.	Earlsboro	15,000	Comp.
Op.	do.	Hominy	3,500	Comp.
Op.	do.	Lima	15,000	Comp.
Op.	do.	Oklahoma City	50,000	Abs.
Op.	do.	St. Louis	30,000	Comp.
Op.	do.	Sasakwa	20,000	Comp.
Op.	do.	Seminole	90,000	Abs.
Op.	do.	do.	130,000	Abs.
Op.	do.	Shamrock	15,000	Comp.
Op.	do.	Shidler	35,000	Comp.
Op.	Skelly Oil Co.	Lyman	30,000	Abs.
Op.	do.	Maramec	5,000	Abs.
Op.	do.	Seminole	50,000	Comb.
Op.	do.	do.	35,000	Abs.
Op.	do.	Slick	15,000	Abs.
Op.	do.	Wynona	15,000	Abs.
Op.	Southwest Production Co.	Bristow	8,000	Abs.
Op.	Stanolind Oil & Gas Co.	Drumright	18,150	Comp.
	do.	do.	- -	Boosting & weathering
Op.	do.	do.	25,000	Comp.
Op.	do.	Shamrock	13,308	Comp.
Op.	do.	do.	6,581	Comp.
Op.	do.	Tonkawa	10,000	Abs.
S.d.	Star Gaso. Co.	North Eram	1,000	Abs.
S.d.	Superior Oil Co.	Earlsboro	10,000	Comp.
S.d.	Test Oil Co.	Dewey	500	Comp.
Op.	Texas Co.	Beggs	4,500	Abs.
Op.	do.	Davenport	12,200	Abs.
Op.	do.	Drumright	11,000	Comp.
Op.	do.	Haskell	6,800	Comb.
Op.	do.	Kiefer	13,900	Comp.
Op.	do.	Maud	25,000	Abs.
Op.	do.	Oilton	2,800	Comp.
Op.	do.	Pawhuska	5,000	Abs.
Op.	do.	Preston	3,000	Comp.
Op.	do.	Tulsa	800	Comp.
Op.	Tidal Refg. Co.	Drumright	15,000	Comb.
Op.	do.	Glenpool	10,000	Comb.
S.d.	Union Gaso. Co.	Cancy	5,000	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	OKLAHOMA (Cont'd).			
Op.	Utilities Production Corp.	Jennings	3,000	Abs.
Op.	Victor Gaso. Co.	Bristow	7,500	Abs.
Op.	do.	do.	1,500	Abs.
Op.	do.	Earlsboro	20,000	Abs.
Op.	do.	Lima	25,000	Abs.
Op.	Warner Caldwell Oil Co.	Nowata	150	Comp.
Op.	do.	do.	1,000	Comb.
Op.	do.	do.	500	Comp.
Op.	do.	do.	3,000	Comp.
Op.	L. H. Wentz	Peckham	5,000	Abs.
Op.	do.	Tonkawa	20,000	Abs.
Op.	Westoak Gaso. Co.	Sayre	10,000	Abs.
Op.	H. F. Wilcox Oil & Gas Co.	Bristow	2,500	Abs.
Op.	Wirt Franklin Pet. Corp.	Oklahoma City	25,000	Abs.
Op.	Wiser Oil Co.	Alluwe	1,000	Comp.
Op.	Wolverine Pet. Corp.	Avant	1,500	Comb.
Op.	do.	do.	4,000	Comb.
Op.	do.	Bartlesville	2,000	Comb.
Op.	J. H. Wright, Est.	Kellyville	4,500	Abs.
	Total	Oklahoma	3,188,617	
	PENNSYLVANIA			
Op.	Alum Rock Gas Co.	Fern	200	Comp.
Op.	Barbary & Hardt	Wildwood	11	Vacuum
S.d.	Harry T. Bartoe	Baldwin	10	Comp.
Op.	Bayliss & Fasenmeyer	Titusville	500	Comp.
Op.	Pryor Berry	Petrolia	25	Comp.
Op.	Clara L. Brown	Kinzua	100	Comp.
Op.	Buzzard Gaso. Co.	Emlenton	50	Comp.
Op.	Canonsburg Steel & Iron Works	Canonsburg	500	Abs.
Op.	Carnegie Natural Gas Co.	Lone Pine	1,000	Abs.
Op.	do.	Mt. Morris	200	Abs.
Op.	do.	Waynesburg	4,500	Abs.
Op.	M. A. Carpenter	Karns City	150	Comp.
Op.	Chambers Oil Co.	--	25	Comp.
Op.	do.	--	75	Comp.
Op.	Clinger Oil & Gas Co.	Truemans	500	Comp.
Op.	do.	Tidioute	500	Comp.
Op.	John G. Cochran & Co.	Sheffield	1,100	Abs.
Op.	C. J. Coffin	Karns City	66	Comp.
Op.	do.	do.	60	Comp.
Op.	Columbia Gas & Electric Corp.	Claysville	3,800	Abs.
S.d.	do.	Kane	4,500	Abs.

DETAIL BY STATES—Continued

Status	Company	Location	Daily capacity, gallons	Type
	PENNSYLVANIA (Cont'd			
S.d.	Columbia Gas & Electric Corp.	Majorsville	8,500	Abs.
S.d.	do.	Waynesburg	10,000	Abs.
Op.	Cook Oil Lease	Mayburg	300	Comp.
Op.	M. G. & C. R. Daugherty	Petrolia	27	Comp.
Op.	H. G. Dunlap	Chicora	8	Comp.
Op.	H. G. Dunlap & Zeno F. Heminger	do.	25	Comp.
Op.	E. O. Edwards	Titusville	150	Comp.
Op.	Eisworth, Hefron & Co.	Lucinda	400	Comp.
Op.	Elliott Bros.	Karns City	5,000	Comp.
Op.	Equitable Gas Co.	Marianna	2,000	Abs.
Op.	do.	Waynesburg	3,500	Abs.
S.d.	Faith Oil & Gas Co.	Sheffield	300	Comp.
Op.	Federal Oil & Gas Co.	Oakdale	250	Comp.
Op.	Chas. Fetzes, et al	Butler	10	Comp.
Op.	Joseph E. Fleming	Grand Valley	500	Comp.
Op.	Forest Chemical Co.	Barnes	500	Abs.
Op.	Forest Oil & Gas Co.	Clinton	50	Comp.
Op.	Wm. Frazier, G. M.	Kaylor	8	Comp.
Op.	Mrs. J. S. Gould & Son	Butler	10	Comp.
Op.	John B. Hadden	Sheffield	100	Comp.
Op.	Hague & Co.	Tidioute	500	Pumps
Op.	Haskell Bros.	do.	1,000	Comp.
Op.	Haskell, Roth & Bayliss	do.	600	Comp.
Op.	Hickey & Russell	Henry's Mills	300	Comp.
Op.	Hope Construction & Refg. Co.	Brave	20,000	Abs.
Op.	do.	Imperial	3,600	Char.
S.d.	do.	McKeesport	2,600	Char.
Op.	do.	Mayport	1,500	Abs.
S.d.	do.	Yatesboro	900	Abs.
Op.	Fred W. Jackson	Chicora	300	Comp.
Op.	E. H. Jennings Bros. Co.	Noblestown)		(Comp.
Op.	do.	do.)	1,700	(Comp.
Op.	do.	do.)		(Comp.
Op.	Kapp & Brocklehurst	Tidioute	100	Vacuum
Op.	E. E. & A. McIntosh	Karns City	10	Comp.
Op.	Chas. T. McKeekin	do.	50	Comp.
Op.	Mars Co.	Lewis Run	6,500	Abs.
S.d.	do.	Miola	1,800	Abs.
Op.	do.	Oil City	4,000	Abs.
S.d.	do.	Queen	1,500	Abs.
Op.	do.	Van	7,500	Abs.
Op.	Orie L. Martin	Butler	7	Comp.
Op.	Midland Oil Corp.	--	1,200	Comp.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	PENNSYLVANIA (Cont'd)			
Op.	Miller & Marshall	Karns City	30	Comp.
Op.	Miller Gould & Co.	--	1	Comp.
Op.	James Montgomery	McKeesport	100	Comp.
Op.	Moore, Way & Harrison	Titusville	200	Comp.
Op.	National Gaso. Co.	West Hickory	75	Comp.
Op.	W. C. Norris	Tidioute	280	Comp.
S.d.	North Penn Gas Co.	Shinglehouse	600	Abs.
Op.	Sarah C. O'Hara	Karns City	100	Comp.
Op.	H. R. Parker	Chicora	25	Comp.
Op.	Pennsylvania Oil Co.	Ludlow	10,000	Abs.
S.d.	E. O. Pequignot	West Hickory	250	Vacuum
Op.	Porter Bros.	--	150	Comp.
Op.	President Oil Co.	Fryburg	500	Comp.
Op.	do.	Bruin	50	Comp.
Op.	do.	Emlenton	50	Comp.
Op.	H. D. Price	Renfrew	25	Comp.
Op.	do.	Butler	15	Comp.
Op.	S. Y. Ramage	Tidioute	20	Vacuum
Op.	Red Brush Oil Co.	Tionesta	300	Comp.
Op.	Ritzert Bros.	Chicora	70	Comp.
Op.	Sand Hill Lease	Tidioute	105	Comp.
Op.	George K. Say	Petrolia	52	Comp.
Op.	Wm. E. Sherwin	Karns City	33	Comp.
Op.	Sloan & Zook Co.	Kane	1,200	Abs.
Op.	South Penn Oil Co.	Braden	50	Comp.
Op.	do.	Bradford	550	Comp.
Op.	do.	Chaffee	25	Comp.
Op.	do.	Chicora	150	Comp.
Op.	do.	Evans City	25	Comp.
Op.	do.	do.	450	Comp.
Op.	do.	do.	125	Comp.
Op.	do.	do.	150	Comp.
Op.	do.	do.	50	Comp.
Op.	do.	Guffey	150	Comp.
Op.	do.	Henry's Mills	300	Comp.
Op.	do.	Kane	100	Comp.
Op.	do.	Noblestown	125	Comp.
Op.	do.	do.	1,600	Comp.
Op.	do.	Parker	100	Comp.
Op.	do.	Petrolia	50	Comp.
Op.	do.	Porkey	650	Comp.
Op.	do.	President	500	Comp.
Op.	do.	New Freeport	1,000	Comp.
Op.	do.	South Heights	550	Comp.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	PENNSYLVANIA (Cont'd)			
Op.	South Penn Oil Co.	Sturgeon	1,500	Comp.
Op.	do.	Tiona	450	Comp.
Op.	do.	Wright Station	550	Comp.
Op.	Southern Oil Co.	Butler	30	Comp.
Op.	do.	Clarion	60	Comp.
Op.	do.	Elmo	150	Comp.
Op.	do.	Miola	150	Comp.
Op.	do.	Pleasantville	25	Comp.
Op.	do.	Volant	10	Comp.
Op.	W. J. Stephens	Grand Valley	150	Comp.
Op.	Stoneham Gaso. Co.	Stoneham	250	Comp.
Op.	Success Oil Co.	Pioneer	1,500	Comp.
Op.	Surety Oil Co.	Titusville	500	Comp.
Op.	R. L. Thomas, Jr.	Tidioute	250	Vacuum
Op.	Tompsett Bros.	Tidioute	100	Vacuum
Op.	Triangle Oil Co.	--	250	Pressure
Op.	Triumph Pet. Co.	Tidioute	175	Comp.
Op.	Ulf Bros.	do.	6,000	Gas Pumps
S.d.	Geo. Veach	do.	500	Abs.
Op.	A. J. & J. B. Vogebacker	Clarion	42	Comp.
S.d.	C. W. Warner	Titusville	20	Comp.
Op.	Warner-Caldwell Oil Co.	do.	1,000	Comp.
Op.	D. H. Wheeler	Petrolia	300	Comp.
Op.	Jacob W. Will	Canonsburg	55	Comp.
	Total	Pennsylvania	140,125	
	TEXAS			
Op.	Airolene Gaso. Corp.	Lela	10,000	Abs.
Op.	Amerada Pet. Corp.	Coleman	7,500	Abs.
Op.	Arab Gaso. Corp.	Eastland	25,000	Abs.
Op.	Big Lake Oil Co.	Texon	50,000	Abs.
Op.	do.	do.	15,000	Abs.
Op.	Breckenridge Gaso. Co.	Breckenridge	12,000	Abs.
Op.	Canadian River Gas Co.	Dumas	25,000	Abs.
Op.	Cannon Gaso. Co.	Amarillo	4,000	Abs.
Op.	Centennial Oil & Gas Co.	Goldsboro	7,500	Abs.
Op.	Coltexo Corp.	Lefors	100,000	Abs.
Op.	Columbian Gaso. Corp.	Shamrock	10,000	Abs.
Op.	Consolidated Gaso. Co.	Eastland	16,000	Abs.
Op.	Continental Oil Co.	Burkburnett	2,000	Comp.
Op.	Desdemona Gaso. Co.	Desdemona	4,000	Abs.
S.d.	Empire Oil & Refg. Co.	Borger	3,000	Char.
Op.	do.	Pampa	30,000	Abs.
S.d.	do.	do.	2,000	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	TEXAS (Cont'd)			
Op.	Forrest E. Gilmore Co. of Tex.	Pampa	20,000	Comb.
Op.	Graham Oil & Gas Co.	Graham	8,000	Abs.
Op.	Gulf Production Co.	Breckenridge	4,900	Abs.
Op.	do.	do.	10,800	Abs.
	do.	do.		Booster
Op.	do.	do.	4,365	Comp.
Op.	do.	Ranger	8,700	Comp.
Op.	Hanlon Gaso. Co.	Breckenridge	40,000	Abs.
Op.	Henderson Co.	Sanford	35,000	Abs.
Op.	Humble Oil & Refg. Co.	Bellville	10,000	Comb.
Op.	do.	Kilgore	5,000	Comp.
Op.	do.	London	10,000	Comp.
Op.	do.	McCamey	22,000	Comb.
Op.	do.	Neshes	12,000	Comb.
Op.	do.	Rising Star	10,000	Comb.
S.d.	LaSalle Pet. Co.	Burkburnett	15,000	Comp.
Op.	Lone Star Gas Co.	Brazos	5,000	Abs.
Op.	do.	Cisco	10,000	Abs.
Op.	do.	Desdemona	2,000	Comp.
Op.	do.	Gainesville	15,000	Abs.
Op.	do.	Gordon	30,000	Abs.
Op.	do.	Petrolia	12,000	Abs.
Op.	do.	Ranger	3,000	Comp.
Op.	do.	do.	2,000	Comp.
Op.	do.	Rising Star	2,000	Comp.
Op.	Lone Star Gaso. Co.	Breckenridge	31,000	Abs.
Op.	do.	Eastland	6,500	Abs.
Op.	do.	Olden	8,500	Abs.
Op.	do.	Ranger	20,500	Abs.
Op.	do.	do.	20,500	Abs.
Op.	do.	do.	20,500	Abs.
Op.	do.	do.	20,500	Abs.
S.d.	Magnolia Pet. Co.	Breckenridge	6,420	Comb.
Op.	do.	Burkburnett	4,396	Comp.
Op.	do.	Desdemona	6,666	Comb.
Op.	do.	Electra	4,175	Comp.
Op.	do.	LeFors	18,583	Comb.
Op.	do.	Lela	1,520	Abs.
Op.	do.	Olden	7,093	Comp.
Op.	do.	Pampa	4,478	Comb.
Op.	do.	Skellytown	4,408	Comb.
Op.	Mid-Kansas Oil & Gas Co.	Bristow	10,000	Comb.
Op.	do.	Caddo	12,000	Abs.
Op.	do.	Eliasville	5,000	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	TEXAS (Cont'd)			
Op.	Midland Gaso. Co.	Coleman	15,000	Abs.
Op.	National Supply Co. of Tex.	Shamrock	11,000	Abs.
Op.	Ockland Gas Products Co.	Desdemona	2,500	Abs.
Op.	Orfic Gaso. Prod. Co.	Desdemona)		(Comp.
Op.	do.	do.)	7,000	(Comp.
Op.	Pacific American Gaso. Co.	Borger	30,000	Abs.
Op.	Phillips Pet. Co.	Borger	40,000	Abs.
Op.	do.	do.	42,000	Abs.
Op.	do.	do.	22,000	Abs.
Op.	do.	do.	40,000	Abs.
Op.	do.	do.	50,000	Abs.
Op.	do.	do.	50,000	Abs.
Op.	do.	do.	25,000	Abs.
Op.	do.	Breckenridge	12,000	Abs.
Op.	do.	do.	15,000	Abs.
Op.	do.	do.	12,000	Abs.
Op.	do.	Crane	70,000	Abs.
Op.	do.	Frankell	8,500	Abs.
Op.	do.	Gorman	12,000	Abs.
Op.	do.	Graham	9,000	Abs.
Op.	do.	do.	7,500	Abs.
Op.	do.	Le Fors	15,000	Abs.
Op.	do.	Necessity	3,000	Abs.
Op.	do.	Odessa	15,000	Abs.
Op.	do.	Pampa	75,000	Abs.
Op.	do.	do.	75,000	Abs.
Op.	do.	do.	60,000	Abs.
Op.	do.	do.	40,000	Abs.
Op.	do.	do.	90,000	Abs.
Op.	do.	Panhandle	15,000	Abs.
Op.	do.	do.	25,000	Abs.
Op.	do.	Pioneer	12,000	Abs.
Op.	do.	Sanford	25,000	Abs.
Op.	do.	Sedwick	45,000	Abs.
Op.	do.	South Bend	5,000	Abs.
Op.	Philmore Gaso. Co.	Bryson	16,000	Comb.
Op.	Pure Oil Co.	Van	37,000	Comp.
S.d.	Red River Oil Co.	Electra	25,000	Abs.
Op.	Roeser & Pendleton	Albany	25,000	Abs.
Op.	Shamrock Oil & Gas Co.	McLean	14,000	Abs.
Op.	Shell Pet. Corp.	Pampa	7,000	Abs.
Op.	do.	do.	13,000	Abs.
Op.	do.	do.	7,000	Abs.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	TEXAS (Cont'd)			
Op.	Signal Gaso. Co. of Tex.	Best	70,000	Abs.
S.d.	Silurian Oil Co.	Burkburnett	1,000	Comp.
Op.	Skelly Oil Co.	Borger	75,000	Comb.
Op.	do.	Burkburnett	25,000	Comp.
Op.	do.	do.	8,000	Comp.
Op.	do.	Skellytown	58,000	Comb.
Op.	do.	Stinnett	9,000	Abs.
Op.	South Plains P.L. Co.	Amarillo	10,000	Abs.
Op.	Stanolind Oil & Gas Co.	Burkburnett	12,000	Comp.
Op.	do.	Desdemona	10,000	Abs.
Op.	do.	do.	3,000	Comp.
Op.	Texas Co.	Burkburnett	33,000	Comp.
Op.	do.	Electra	9,300	Comp.
Op.	do.	Olney	7,000	Comp.
Op.	Texas & Pacific Coal & Oil Co.	Caddo	15,000	Abs.
Op.	do.	Strawn	5,000	Comb.
Op.	United Gas Public Service Co.	Latex	8,000	Abs.
Op.	do.	Refugio	25,000	Abs.
S.d.	Vollwin Gaso. Co.	Frankell	4,500	Abs.
Op.	Waggoner Refg. Co.	Electra	20,000	Abs.
Op.	Ward Gaso. Co.	Breckenridge	5,000	Abs.
Op.	Western Oil Corp. of Tex.	Burkburnett	10,000	Comp.
Op.	do.	do.	10,000	Comp.
Op.	do.	Electra	10,000	Abs.
Op.	H. F. Wilcox Oil & Gas Co.	Pampa	11,000	Abs.
	Total	Texas	2,410,804	
	WEST VIRGINIA			
Op.	American Oil Development Co.	Frew	11,200	Abs.
Op.	do.	Meadville	125	Comp.
Op.	do.	St. Marys	175	Comp.
Op.	Blue Creek Oil & Gas Co.	--	400	Comp.
Op.	Carbide & Carbon Chemicals Corp.	Hastings	1,500	Comp.
Op.	do.	Diamond	3,300	Comp.
Op.	Carnegie Natural Gas Co.	Hundred	3,300	Abs.
Op.	do.	Pine Grove	3,000	Abs.
Op.	do.	Toll Gate	100	Abs.
Op.	do.	Underwood	3,000	Abs.
Op.	do.	Woodruff	1,800	Abs.
Op.	Casto Oil Co.	St. Marys	300	Comp.
Op.	Chemical Oil & Gas Co.	Grantsville	500	Comb.
Op.	Clendenin Gaso. Co.	Clendenin	800	Comb.
Op.	Columbia Oil & Gaso. Co.	Charleston	2,000	Char.
Op.	do.	do.	25,000	Char.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	WEST VIRGINIA (Cont'd)			
Op.	Columbia Oil & Gas. Co.	Clendenin	18,000	Abs.
Op.	do.	do.	1,200	Abs.
Op.	do.	Ft. Gay	3,500	Char.
Op.	do.	Mammoth	2,500	Abs.
Op.	do.	do.	1,000	Abs.
Op.	do.	Ona	18,000	Abs.
Op.	do.	Porter	1,500	Comp.
Op.	do.	Sandyville	40,000	Char.
Op.	do.	Spencer	10,000	Char.
Op.	do.	St. Albans	3,500	Char.
S.d.	do.	Walgrove	1,500	Comp.
Op.	Dinsmoor & Co.	--	750	Comp.
Op.	Dun Mar Oil & Gas Co.	North	50	Comp.
Op.	Falling Rock Cannel Coal Co.	Weir	3,000	Abs.
Op.	Federal Oil & Gas Co.	Elizabeth	250	Comp.
Op.	do.	Weston	500	Comp.
Op.	R. T. Hapgood	Cedar Grove	3,500	Char.
Op.	Hope Construction & Refg. Co.	Barren Creek	14,000	Abs.
Op.	do.	Bristol	8,000	Abs.
Op.	do.	Littleton	15,000	Abs.
Op.	do.	Mt. Claire	2,500	Abs.
Op.	do.	Middlebourne	400	Comp.
Op.	do.	Pine Grove	40,000	Abs.
Op.	do.	Rachel	10,000	Abs.
Op.	do.	Salem	3,500	Abs.
Op.	do.	Sistersville	1,500	Comp.
Op.	do.	do.	1,000	Comp.
Op.	do.	do.	400	Abs.
S.d.	do.	Spencer	1,000	Abs.
Op.	do.	Waverly	5,000	Abs.
Op.	Hudson Oil Co.	Cairo	75	Comp.
Op.	Kanawha Oil Co.	Jacksonburg	100	Comp.
Op.	do.	do.	1,300	Comb.
Op.	do.	do.	100	Comp.
Op.	Melrose Oil & Gas Co.	Middlebourne	50	Comp.
Op.	do.	do.	50	Comp.
Op.	New York Pet. Co.	Cairo	100	Comp.
Op.	do.	Lima	100	Comp.
Op.	Oil & Gas Co.	Harrisville	250	Comp.
Op.	Owens, Libby & Owens	Charleston	10,000	Abs.
Op.	Pittsburgh & W. Va. Gas Co.	Hundred	3,500	Abs.
Op.	Pure Oil Co.	Sistersville	300	Comp.
Op.	do.	Dawes	15,000	Comb.

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	WEST VIRGINIA (Cont'd)			
Op.	S. Y. Ramage	Bens Run	15	Vacuum
Op.	Reno Oil Co.	Rutherford)		(Comp.
Op.	do.	Sistersville)	1,700	(Comp.
Op.	Reserve Gas Co.	Valley Chapel	20,000	Abs.
Op.	P. Schlegel & Edward Fried	Sistersville	85	Comp.
Op.	South Penn Oil Co.	Alvy	1,500	Comp.
Op.	do.	Bealls Mills	500	Comp.
Op.	do.	Blue Creek	3,000	Comp.
Op.	do.	do.	3,000	Comp.
Op.	do.	Bula	400	Comp.
Op.	do.	Clay	2,200	Comp.
Op.	do.	Coco	2,200	Comp.
Op.	do.	Fink	1,000	Comp.
Op.	do.	Glenville	1,100	Comp.
Op.	do.	Mannington	1,500	Comp.
Op.	do.	McFarlan	2,000	Comp.
Op.	do.	Metz	1,500	Comp.
Op.	do.	Middlebourne	300	Comp.
Op.	do.	do.	200	Comp.
Op.	do.	Pine Grove	2,500	Comp.
Op.	do.	Shinnston	400	Comp.
Op.	do.	Shirley	400	Comp.
Op.	do.	do.	1,200	Comp.
Op.	do.	do.	500	Comp.
Op.	do.	Smithfield	3,000	Comp.
Op.	do.	Spencer	2,600	Comp.
Op.	do.	Statler Run	2,200	Comp.
Op.	do.	Walton	2,400	Comp.
Op.	do.	do.	400	Comp.
Op.	do.	Wolf Summit	2,000	Comp.
Op.	do.	Yawkey	3,000	Comp.
Op.	Southern Oil Co.	Macfarlan	1,000	Comp.
S.d.	do.	do.	1,400	Abs.
Op.	do.	Porters Falls	40	Abs.
Op.	do.	Sistersville	200	Comp.
Op.	Tuel & Thoenen	do.	100	Comp.
Op.	Tyler Oil Co.	Middlebourne	300	Comp.
Op.	Union Gaso. & Oil Corp.	Jane Lew	7,500	Abs.
Op.	do.	Rosbys Rock	6,500	Abs.
S.d.	do.	Porters Falls	20,000	Abs.
Op.	Wiser Oil Co.	Spencer	50	Comp.
	Total	West Virginia	388,365	

DETAIL BY STATES--Continued

Status	Company	Location	Daily capacity, gallons	Type
	WYOMING			
Op.	Continental Oil Co.	Columbine	15,000	Abs.
Op.	Midwest Refg. Co.	Casper	100,000	Comp.
Op.	New York Oil Co.	Riverton	2,600	Abs.
Op.	Ohio Oil Co.	Casper	14,400	Abs.
Op.	do.	Kirby	5,000	Abs.
Op.	do.	Manville	7,500	Abs.
Op.	do.	Rock River	3,600	Comp.
Op.	Producers & Refiners Corp.	Rawlins	12,000	Abs.
	Total	Wyoming	160,100	

I. C. 6636

June, 1932

Department of Commerce

United States Bureau of Mines
Scott Turner, Director

Information Circular

Mining Laws of Finland

By

E. P. Youngman

I.C. 6636
June, 1932.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

MINING LAWS OF FINLAND[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper is one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the right of American citizens to explore for minerals and to own and operate mines in various foreign countries. This interpretation was prepared from a translation[3] of the Finnish mining law, forwarded by Edward E. Brodie, American minister at Helsingfors, and transmitted through the courtesy of the State Department.

INTRODUCTION

The mining law now in force in Finland is the Imperial Russian Ukase of 1883,[4] promulgated November 12, 1883, by Czar Alexander III, with the sanction and permission of the Finnish Estates. This law repealed prior legislation, as follows: Ordinance of May 25, 1857, concerning the appropriation of ores and minerals, as well as the right to remove and utilize them; proclamation of January 20, 1868, amending the ordinance of May 25, 1857; proclamation of October 3, 1821, concerning the appropriation of precious metals; and the proclamation of October 30, 1878, concerning prospecting for gold, etc., in Finnish Lapland.

A proposal for a new mining law is still being considered by the Finnish Diet. This new law, if and when promulgated, will differ only slightly from the law of 1883 but will be drafted in more modern language.[5]

1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6636."
2 Rare metals and nonmetals division, U. S. Bureau of Mines.
3 Translation was reviewed by Prof. J. J. Sederholm, Director of the State Geological Commission, Finland.
4 Statutes of the Grand Duchy of Finland, No. 35, his Gracious Imperial Majesty's Claim and Mining Regulation, given in Helsingfors, Nov. 12, 1883.
5 Brodie, Edward E., Mining Laws of Finland: Despatch No. 540, State Dept. file 35155, Helsingfors, Nov. 6, 1931.

RIGHTS OF FOREIGNERS

As far as the provisions of the mining law itself are concerned, the only difference between the rights of aliens and those of the citizens of Finland is that an alien, in order to claim a deposit, must seek permission from the Economy Department of the Senate, whereas a Finnish citizen may apply to a mining inspector or in case of refusal by the inspector may appeal to the Mining Department. (Clauses 6, 7, and 9.)

CLASSIFICATION OF MINERALS

Clause 1, by making certain minerals the objects of prospecting claims (which form the basis for mining concessions), reserves them to the State and thus creates two classes of minerals: (1) State-owned and (2) privately owned.

> Minerals that are the objects of claim are: Gold, silver, quicksilver, platinum, iron, lead, copper, zinc, tin, cobalt, and nickel, and their ores (except bog ore). Lake-ore deposits may be claimed, but only for an industrial establishment, completed or under construction, where such ore is utilized.

All other minerals, by implication, belong to the owner of the surface land.

A second classification is indicated by the distinction made throughout the mining enactment between lode (mountain) deposits, placer (or unconsolidated) deposits, and lake-ore deposits. The "lake-ore deposits" are doubtless similar to oolitic brown iron deposits, which occur in Swedish lakes, and which are renewed every 25 or 30 years after being dredged.

RESTRICTED AREAS

Without the consent of the owner, proprietor, or the authorities in charge of public lands or works, the following mineral deposits may not be claimed:

1. Deposits located less than 100 fathoms from a dwelling or outbuilding, lot, garden, park near a dwelling, factory or buildings belonging to it, or a public building, works, or place.
2. Deposits nearer than 100 fathoms from another claim or mine the tract of which has not been defined.
3. A deposit within fields or meadows.

Without the consent of the Economy Department of the Senate, no deposit may be claimed within the territory reserved for the Crown station at Kultala, in the Enare Chapelry. (Clause 3.)

Prospecting, or
a preliminary mining
may not be obtained.
shall contain (clause

1. Permissi ... the mine is kept in good conditio ...
2. A complet ... the deposit.
3. With resp ... lake-ore deposit, a statement of the size of the area and of the yearly amount of scheduled work.
4. With respect to a lake-ore deposit, a statement as to whether the claim must be followed by the marking out of a mine tract.
5. The distinguishing name of the mine location or ore deposit.
6. The date from which the claim shall be valid.
7. Instructions to the claimant to announce the claim (within 90 days of its issuance) in the church or churches of the district in which the deposit is located.
8. Instructions to the claimant (at least 14 days before work on the deposit may be begun) to furnish the landowner or the proprietor with a certified copy of the claim deed and to inform him where the work will be begun.
9. With respect to a lake-ore deposit, a notification that the claim shall be forfeited should the establishment for which the deed is sought be transferred from the claim holder or his assignees or should the claim holder not complete the establishment within the specified period.

Application

The application for a claim deed shall include (1) the name, profession, and home address of the applicant, (2) the name of the landowner, (3) the name of the claim, its exact position, and the nature of the deposit, and (4) proof, with respect to a lake deposit, that the applicant is the proprietor of the plant (or that he has legal right to establish it) for which the deed is sought, together with a surveyor's certification with respect to the square surface of the premises. When part of a lake is claimed, the boundaries that separate the claim from the rest of the lake shall be specified from shore to shore or from other fixed and visible points, in a "straight and unbroken line, forming no angle."

An application shall be accompanied by the testimony of two responsible men that no impediment exists or by a written permission from the persons concerned. (Clause 4.)

The inspector shall render a decision within 30 days from the receipt of the application. He shall drop proceedings should he find (1) that the

applicant has no right to a claim deed, (2) that the land applied for is not subject to appropriation, or (3) that other impediments exist. Written appeal from the decision of the inspector may be taken to the Mining Department (whose decision is final), at the latest before 12 o'clock of the thirtieth day after the receipt of the inspector's refusal (that day not included). (Clauses 4, 6, and 7.)

Priority Rights

A prospector may acquire priority right to a claim by filing an application with the bailiff of his district and receiving a certificate, which is valid from the day the application was made if it is submitted to the mining inspector within 60 days for the receipt of a claim deed but valid only from the day it was received by the inspector if not submitted within the 60-day period. (Clause 5.)

Area

With respect to lode and placer claims, a claim deed for a single deposit shall not apply to a larger area than can be worked properly, nor may it cover several deposits in different places. (Clause 10.)

With respect to lake deposits, clause 10 reads:

> A claim deed shall not include more than one lake, the area of which may not be more than half a square mile, or more than half a square mile of a larger lake.

Duration

The life of a claim deed for a lode deposit is 2 years, and that for a placer deposit is 1 year,--claim rights being forfeited after the 2-year and 1-year periods of exploration unless applications are made for mining concessions. (Clause 25.) A claim deed covering a lake-ore deposit with respect to which a mining tract must be laid out is good for 1 year from the date of the beginning of ore removal,--removal being permitted upon notification to the public and the landowner of the existence of the claim. (Clauses 24 and 41.)

Surface Rights

A claim holder has the right to use adjoining land to the extent necessary for the exploratory or other experimental work required before a mine tract may be laid out,--such work, however, not to take place within 100 fathoms of a dwelling or other building without the express permission of the landowner. Such a right carries with it the obligation on the part of the claimant (1) to compensate the owner or proprietor in full in the form of a

yearly fee and remuneration for all damages that may have been occasioned by the abandondment of the claim before the laying off of a mining tract and (2) to furnish security, should it be requested, before work is begun. (Clauses 15 and 17.)

A claim holder has the right to any land necessary for the storage of ore or for its easy removal. (Clause 20.) With respect to land under the immediate administration of the Crown, public property belonging to the Crown, or a lake that does not belong to any particular estate, a claimant has the right to all land necessary for mine construction or for ore removal but must pay compensation to the tenant or the resident. (Clause 21.)

Transfer

The transferee of a claim deed shall, within 30 days of the receipt of the transfer, register it with the "mining master" and, within 60 days of the mining master's endorsement, notify the landowner of the transaction and publish the claim deed. (Clause 14.)

The refusal of a transfer may be appealed to the Mining Department,--a written appeal to be made at the latest before 12 o'clock of the thirtieth day after receipt of the refusal. (Clause 7 and 14.)

A claim deed for lake or bog ore may be transferred only to the owner or the constructor of a plant for the utilization of the ore. (Clause 14.)

Abandonment and Forfeiture

Abandonment.--A claim holder may voluntarily abandon a claim by notifying the landowner or the proprietor in writing of his intention and by paying the current annual land rent, together with compensation for damages caused to land used for ancillary purposes. Should a claim be abandoned without the required notice, the landowner may take possession of the land and sue for the recovery of damages due to him by the claimant, who until compensation shall have been paid shall be responsible for the full sum of the yearly land fee. A claimant abandoning construction shall be obliged, under penalty of 50 marks, to give notice to the mining inspector before the end of the month of January of the year following that in which the abandonment took place. (Clause 181.)

Forfeiture.--Forfeiture of claim rights shall follow the neglect of the first year's obligatory work, except as abeyance may have been granted to the constructor of a plant for the utilization of lake ore. Should the prescribed work schedule be neglected without permission (except as noted in the foregoing sentence), and should complaint concerning the negligence be made to the district court within two years thereof, the concessionaire shall forfeit his right to the deposit. (Clause 18, 44, and 45.)

The right to claim placer gold deposits shall be forfeited should the prospector neglect to pay the required fee at the prescribed time. (Clause 13.)

MINING CONCESSIONS

The holder of a claim deed may obtain a mining concession whenever he is able to prove that the mineral vein has been explored. The claimant of an entire lake or of part of a lake the remainder of which can be distinguished by channels, brooks, mountain ridges, or similar fixed and perceptible natural boundaries is exempt from the obligation of applying for a concession. Unless the claim deed definitely states that a mining tract shall be laid out, no concession need be sought for a lake-ore deposit.

A concession gives to the concessionaire the sole right to carry on work both above and below ground. (Clause 25 and 40.)

Application

After a request has been made for a survey, or the marking out of a mining tract, application for a concession shall be filed within 1 year from the date of the claim deed for a lode deposit, within 2 years for a placer deposit, and within 1 year from the beginning of the removal of ore for a lake deposit. If the application is not presented within the prescribed time, the claim rights are considered forfeited. (Clause 25.)

An application (which shall be written) shall submit the name and address of the landowner or landowners within whose domain the tract is desired. (Clause 25.)

Survey

General.--After a claim holder has applied, or a landowner or proprietor has asked, for the marking out of a mining tract, the mining inspector or some one appointed in his stead shall begin a survey as soon as possible. The person officiating shall be assisted by two trusted men and, when necessary, by a surveyor. (Clauses 26 and 27.) The claimant of a lake deposit (when the claim deed stipulates that a mining tract shall be laid out) shall employ a mining inspector or some other competent person,--the Mining Department to examine the suitability of and to instruct the person proposed. (Clause 40.)

Notice.--Notice of a proposed marking off of a mining tract shall be given to all concerned (to the Governor in case of Crown land or public land under the administration of public officials) with respect to the time and the place of the survey; and notice shall be published also, at least 14 days previously, in the church or churches in the district in which the tract lies. The official in charge shall have the right to apply to local authorities or to the governor of the Province concerned for the right to publish a notice in a church. (Clause 27.)

Procedure.--The absence of the claim holder alone shall prevent a survey's taking place at the designated time. (Clause 28.)

The procedure may be stopped should the official in charge declare a challenge valid, except when the objection is to a trustee, in which circumstance another trustee shall be called. (Clause 29.)

A mining tract on level ground shall be staked out and provided with special marks; and a map in full detail shall be affixed to the record. (Clause 32.)

With respect to a lake-deposit claim, the boundaries that separate the claim from the rest of the lake shall be specified and oriented with respect to fixed and visible points. A special map shall be furnished, if the concessionaire has not obtained a duly authenticated map of the territory in which the boundaries are to be marked. (Clauses 4 and 40.)

Should the survey of a lake deposit be executed by any one other than the mining inspector, the prospective concessionaire shall, within 90 days after completion of the marking, submit the record and the map in duplicate to the mining inspector for approval. For default in the observance of this provision, the claim holder is liable to lose his claim right, in case another prospector has during the ensuing time submitted an application, and in case no valid reason for default can be shown. (Clause 41.)

If a mining tract is approved, the mining inspector shall forward one signed copy of the record and map to the claim holder and file the other one. The mining inspector shall make any necessary alterations. (Clause 41.)

Area

A mining tract shall be laid out so that mining rights shall not exceed 100 fathoms in length or breadth. When this is not possible, because of the proximity of restricted areas, and when free land is available, a tract may be laid out in another form, if the claim holder so requests. (Clause 30.)

Forfeiture

A concessionaire shall forfeit all right to a mining tract if he neglects to pay the required rent when it is due or within 30 days after an ordered suspension of work. (Clause 37.)

WORKING REQUIREMENTS

In order to retain a mineral claim, the holder is subject to the following working requirements (clause 43):

1. In a lode (mountain) deposit, yearly to excavate 1 cubic fathom or remove 5 cubic fathoms of earth on each claim or mining tract or to execute other mining or mine-construction work equal to 200 days' work.
2. In a placer (loose strata) deposit, yearly to remove 10 cubic fathoms of earth.
3. In a lake deposit, yearly to remove 4 cubic fathoms of ore.

The concessionaire of several contiguous mining tracts may, upon approval by the Mining Department of a written application, maintain the right to all of the tracts for one or several years by working one or more of them, provided the total amount of work required from the whole concession is completed. A claim-holder of several lake deposits in the same locality may acquire similar rights.

The working hours are determined as follows (clause 18): If a claim deed is issued before July 1 of any year, the first working year shall extend to the end of the calendar year in which the claim deed is issued; and during that year one-half of the prescribed work shall be accomplished. But if the claim deed is issued during the second half of the year, the first working year shall be reckoned from the beginning of the following calendar year. (The continuance of the work from year to year shall be according to results and agreement.)

Upon written application to the Mining Department, permission to suspend work already begun on a deposit may be obtained for a maximum period of five years and for valid reasons duly corroborated. But no suspension shall be permitted with respect to experimental or exploratory work on other land without the permission of the person having right to the landowner's share. Abeyance of the first year's work will not be allowed until the end of the first working year, except to a constructor of works for the utilization of lake ore. Should a suspension of work cause an increase in the influx of water into an adjacent mine, the claim holder shall compensate the owner thereof for any consequent increase in the charges for handling water. (Clauses 18 and 45.)

RIGHTS OF THE LANDOWNER

With respect to claims.--A landowner has the right to share with the holder of a claim (either lode or placer) to the extent of one-half of the work and profits. A landowner may, irrespective of the existence of a claim deed, remove ore from a lake, but he may not transfer the right to do so to another. (Clause 20.)

A landowner may, during experimental work in a lode or placer deposit, report to the claimant for the execution of his share of the work (either the whole or a part thereof); and he shall enjoy from the time the report is made, a share in the mine or deposit, with the stipulation that he accept a corresponding share in all charges (except those already paid for exploratory or

other experimental work) and that he make compensation to the claim holder for the cost of buildings, implements, and supplies already provided. (Clause 22.)

Should the landowner (at the latest when the mine tract is being marked off) neglect to register for his share of the claim, he loses all right not only to the mineral then being worked but to every other deposit that may be discovered within the territory fixed by the survey, should no agreement to the contrary exist. (Clause 23.)

With respect to a claim on land under the immediate administration of the Crown, on public property belonging to the Crown, or on a lake that does not belong to a particular estate, the tenant or the resident is considered the landowner with respect to receiving compensation for the use of land for mine construction or for the removal of ore. The Governor of the Province shall see that compensation is made and that security for its payment is furnished. (Clause 21.)

The landowner may lay claim to all stocks of ore, buildings, and contrivances that have not been removed within two years following the abandonment of a claim. (Clause 20.)

With respect to concessions.--A landowner may announce his desire (either before or at the time of the marking off of a mining tract) to make use of his share as surface owner, and his decision shall be recorded upon the mining permit, together with the conditions agreed upon. If no agreement is reached with respect to compensation due by the landowner for sums previously expended in the development of the claim, the official in charge shall make a report upon the matter. (Clause 33.)

When a mining tract is laid off, the landowner is entitled to compensation for all land ceded by him; but if he has taken a share in the mining enterprise, he shall receive no greater compensation for the tract "than that to which he is entitled for his other interests in the claim." (Clause 34.)

Should the assignment of a part of a holding make it impossible for the owner or proprietor to make use of the remainder, the concessionaire shall make remuneration for the entire holding, provided the owner filed his claim at the time of the survey. (Clause 35.)

Full compensation for damages, computed at the time of the laying out of the mining tract, shall not prevent the person entitled to compensation from suing for damages incurred during the mining operations. (Clause 38.)

OBJECTIONS, DISPUTES, AND DAMAGES

An objector to the issuance of a claim deed or of a mining tract on the grounds that the deposit is not subject to claim or that the tract is too large

may appeal to the Mining Department. An objector upon any other grounds must submit an appeal to the district court. When an objection has been made, the Governor may forbid the commencement or the continuation of work. A claim holder that has begun operations on a deposit declared to be invalid shall make up the losses and damages caused by his operations; and if he has obtained his claim deed by deception or fraud, he shall be responsible before the law. A complaint with regard to a mining tract laid out in a lake may be submitted to a court. (Clause 12, 39, and 42.)

Dissension among claimants for the same deposit shall be decided by the court of the district in which the deposit is located. (Clause 13.)

Should a dispute arise with respect to the yearly fee or other compensation due to the landowner for land granted for ancillary purposes (experimental work, ore storage, or ore removal), and should a mediator chosen by the disputants fail to bring about a settlement, the case shall be submitted to the district court. Disputes arising with respect to the use of water mains in placer or other mining shall be resolved in the same manner. (Clause 16 and 20.) The Governor of the Province is responsible for obtaining the compensation due to a tenant or resident from a claimant upon Crown land or public land or a lake belonging to no particular estate, when the use of land has been claimed for mine construction or ore removal. (Clause 21.)

ROYALTY AND RENT

Royalty

Five per cent of the gold and silver obtained from lode deposits and a fixed yearly rent from placer gold deposits shall be paid to the Crown. The Economy Department of the Senate shall determine the amount of rent due and shall issue all necessary regulations for its control and collection. (Clause 1.)

Rent

The amount that the concessionaire shall pay to the landowner or assignee for a mining tract shall be computed (at the time of the laying out of the tract) as a fixed yearly rent. Should the grant of part of a holding make it impossible for the owner or proprietor to use the remainder, the concessionaire shall remunerate him for the entire holding, provided a claim therefor is made at the time of the survey. (Clause 35.)

If no agreement can be reached with respect to the amount of rent due, the official in charge shall determine it in accordance with the highest current cost of land in the district, giving consideration to the possible importance of the tract to the owner and to the fact that the landowner is responsible for land taxes. In case of further dispute, the matter shall be submitted to

the district court. When a dispute has been settled, the concessionaire shall pay the amount fixed by the court within 90 days and yearly thereafter. (Clause 36.)

Should a dispute arise as to who is entitled to the rent, the money shall be deposited in the district revenue office or in some other safe financial institution. (Clause 36.)

The tenants of Crown lands or official residences shall receive the rent from tracts ceded from their holdings. With respect to other rented land, the use of which has been ceded, the owner shall collect the rent and compensate the occupants for any losses caused by the concession. (Clause 37.)

MISCELLANEOUS

Mining Regulations

Mining regulations are under the general jurisdiction of the Mining Department and under the direct jurisdiction of the supervising mining inspectors, who not only enforce the existing regulations but give special instructions when necessary. (Clause 46.) Regulations covered by clauses 47 to 52 are, briefly, as follows:

1. Timbering, ventilation, and all equipment must be kept up so so as to insure both the permanence of the mine and the safety of workers. (Clause 47.) The mining inspector, after consultation with the owner or manager, shall indicate the proper placing of "straps," supports, etc. (Clause 48.)
2. Loose rock shall not be left in the mine unless required by the mining system in operation; nor shall it be dumped into another mine room or into adjacent old mines without permission from the inspector. An abandoned or forfeited mine may not be filled without permission from the Mine Department. (Clause 47.)
3. If an inspector should find that an increased inflow of water or some other condition is endangering the security of life or of the mine or of an adjacent mine or estate, he shall order whatever measures are necessary or shall order suspension of operations, applying to the police authorities if it is advisable. (Clause 49.)
4. With respect to operating mines that are partly underground, the mine owner shall (if so required by the Mining Department) prepare, at his own expense, an exact and complete map of the mine, upon penalty for default of having the map printed by the department at the owner's expense. (Clause 51.)
5. During both exploring and mining operations, exact returns with respect to the work done, amount of ore, metal, and metalliferous rock taken out, number of work days employed, and the costs incurred shall be submitted to the mining inspector for each year before the end of February of the succeeding year. In addition to this obligation (which is incumbent

upon all classes of miners), the owner or manager of a placer deposit or of a lake deposit shall submit any further information that the mining administration may require for the keeping of exact mining statistics. (Clause 52.)

Penalties and Fines

Deliberate negligence or carelessness on the part of the owner, manager, or employee with respect to any mining regulation shall incur a fine of not more than 500 marks. (Clause 50.)

Disturbing, damaging, or removing supports, "straps," foundations, mine buildings, or timbering by the mine owner, manager, or any one else, without express permission from the mining inspector, is subject to a maximum fine of 2,000 marks or imprisonment for two years, even though no injury may have occurred. If injury should occur, the offender shall be liable under the general laws also. (Clause 46.)

Negligence with respect to the filing of returns (as to work done, metals or ore raised, number of days employed, or costs incurred) is subject to a fine of 20 marks. After notification to, and after hearing, all parties concerned, the Governor shall sentence the offender to a fine and shall set another date for delivery of the report or information, upon pain of an increased fine, not in excess of 400 marks, however. (Clause 52.)

Fines, if defaulted, may be converted into prison terms, in accordance with clause 10 of the law of execution and the royal proclamation of March 23, 1807. (Clause 53.) The prosecuting attorney, upon notice from the plaintiff or mining official, shall bring action against violators of mining regulations. (Clause 54.)

Fines imposed according to the mining statute shall be divided between the Crown and the prosecutor. (Clause 53.)

Appeal

Dissatisfaction with the mining inspector's instructions may be taken by appeal to the Mining Department, which may order an investigation to be held on the premises, and whose decision is final. (Clause 50.)

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UNITED STATES BUREAU OF MINES
Scott Turner, Director

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RESEARCH ACTIVITIES IN THE MINERAL INDUSTRIES OF THE UNITED STATES

BY

A. C. Fieldner and Alden H. Emery

I. C. 6637 September, 1932

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

RESEARCH ACTIVITIES IN THE MINERAL INDUSTRIES OF THE UNITED STATES[1]

A list of problems reported to the Bureau of Mines in 1930 and 1931

By A. C. Fieldner[2] and Alden H. Emery[3]

This list of problems engaging the attention of the mineral industries was prepared under the sponsorship of the committee on correlation of research of the American Institute of Mining and Metallurgical Engineers. Questionnaires were sent to practically all industrial, institutional, university, and governmental research departments. The response was fairly satisfactory. As might be expected, many private commercial corporations did not report individual research problems, but replied in general terms. However, the universities, and the governmental and other public institutions responded freely and submitted lists of problems on which they were working. Grateful acknowledgment is made to all who answered the questionnaires, without whose help no catalogue could have been prepared.

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1 The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6637."
2 Chief engineer, Experiment Stations Division, U. S. Bureau of Mines.
3 Assistant to chief engineer, Experiment Stations Division, U. S. Bureau of Mines.

For convenience of reference, the problems have been listed in divisions and subdivisions as follows:

A. COAL

I. Occurrence
II. Properties, composition, and testing
III. Mining, safety, and health
IV. Cleaning, preparation, and briquetting
V. Storage, transportation, weathering, and spontaneous combustion
VI. Combustion, furnaces, and smoke abatement (including gas)
VII. Carbonization
VIII. Carbonization products
IX. Complete gasification, hydrogenation, and synthetic products
X. Economics and miscellaneous

B. PETROLEUM, NATURAL GAS, and ASPHALT

I. Origin, geology, and prospecting
II. Properties and tests: Motor fuels and lubricants
III. Properties and tests: Miscellaneous
IV. Development and production
V. Transportation and storage
VI. Refining
VII. Special chemical processing
VIII. Utilization: Motor fuels and lubricants
IX. Utilization: Carbon black
X. Utilization: Furnaces and combustion
XI. Utilization: Miscellaneous
XII. Safety, health, and economics

C. NONMETALLIC MINERALS and PRODUCTS (other than Coal (A), Petroleum, Natural gas, and asphalt (B))

I. Ceramic raw materials
II. Heavy clay products and refractories
III. Porcelain, enamels, glass, and electrical insulators
IV. Porous ceramic products, heat insulators, and asbestos
V. Lime, gypsum and plaster
VI. Cement and concrete (including aggregates)
VII. Sand, gravel, and crushed stone
VIII. Building stone and roofing material
IX. Pigments
X. Mineral fillers, clarifiers, and detergents
XI. Acids, alkalies, salts, and sulphur
XII. Phosphates and their derivatives
XIII. Water, water treatment, and stream pollution
XIV. Safety, health, and miscellaneous

D. METALLIC ORES AND PRODUCTS

I. Origin, occurrence, prospecting, mining, and economics
II. Beneficiation
III. Methods of analysis and test
IV. Properties: Thermal, electrical, and magnetic
V. Properties: Corrosion, erosion, and embrittlement
VI. Properties: Failure, endurance, fatigue, and crystal structure
VII. Properties: Other mechanical
VIII. Properties: Miscellaneous
IX. Extraction and refining
X. Steel and alloy steel manufacture
XI. Nonferrous metal and alloy manufacture
XII. Casting and melting
XIII. Electroplating and metallic coating
XIV. Welding
XV. Utilization and development
XVI. Safety and health

E. GENERAL

I. Occurrence, prospecting, mining, and economics
II. Beneficiation and transportation
III. Safety and health
IV. Miscellaneous

Individual problems fitting under more than one classification are repeated.

A. COAL

I. Occurrence

Anthracite Institute (in cooperation with Lehigh University), 90 West Street, New York, N. Y.
Geology and correlation of Pennsylvania anthracite.

Birmingham-Southern College, Department of Geology, Birmingham, Ala.
Cyclic sedimentation in the coal fields of the Birmingham district.

Indiana State Conservation Department, Division of Geology, Indianapolis, Ind.
Origin of Indiana coals.

Iowa Geological Survey, Des Moines, Iowa.
Geology of Iowa coals.

Lehigh University, Department of Geology (in cooperation with the Anthracite Institute), Bethlehem, Pa.
Geology and correlation of Pennsylvania anthracite.

State University of Montana, Department of Geology, Missoula, Mont.
Occurrence, mining, and utilization of Montana coal and lignite.

South Dakota Geological Survey, University of South Dakota, Vermillion, S. Dak.
Location and geology of lignite deposits.

United States Geological Survey, Washington, D. C.
Geologic relations, areal distribution, origin, and quantity of coal available in all deposits.

Vanderbilt University, Department of Geology, Nashville, Tenn.
Distribution and quality of the coals of the western coal field of Kentucky and of the northern coal field of Tennessee.

II. Properties, Composition, and Testing

American Society for Testing Materials (in cooperation with Battelle Memorial Institute), 1315 Spruce Street, Philadelphia, Pa.
Pulverizing characteristics of coal.

American Society for Testing Materials (in cooperation with the United States Bureau of Mines), 1315 Spruce Street, Philadelphia, Pa.
Standardization of the agglutinating test of coal.

Anthracite Institute (in cooperation with Lehigh University), 90 West Street, New York, N. Y.
The physical and chemical properties of Pennsylvania anthracite, including X-ray and microscopical studies, distillation, and physical measurements, such as specific heats, electrical conductivity, and coefficient of expansion.

Anthracite Institute (in cooperation with Pennsylvania State College), 90 West Street, New York, N. Y.
Properties of anthracite which will permit it to be used as a commercial carbon in the chemical and metallurgical industries.

Anthracite Institute (in cooperation with Yale University), 90 West Street, New York, N. Y.
Ignition of anthracite fuels.

Battelle Memorial Institute (in cooperation with the American Society for Testing Materials), 505 King Avenue, Columbus, Ohio.
Pulverizing characteristics of coal.

Carnegie Institute of Technology, Coal Research Laboratory, Pittsburgh, Pa.
Significance of true density measurements of coal and coke.
High-vacuum distillation to obtain the primary decomposition products of coal.
The action of solvents on coal.
Action of chlorine on coal to determine the nature of coal substance.
Development of microchemical methods for the analysis of coal and its products.

Carnegie Institute of Technology (in cooperation with the United States Bureau of Mines), Pittsburgh, Pa.
Standardization of the agglutinating test of coal.
Chemistry of decay in relation to peat and coal formation.
Occluded gases in coal.

University of Dubuque, 2050 Delhi Street, Dubuque, Iowa.
Fusion point of the ash of various coals.

Fuel Engineering Co. of New York, 116 East 18th Street, New York, N. Y.
Grindability of coal for pulverizer service.

Fuller Lehigh Co., Station 1, Fullerton, Pa.
Comparison of the grindability of coal as indicated by two types of grindability machines.

University of Illinois, Department of Botany, Urbana, Ill.
The botanical contents of coal balls.

University of Illinois, Engineering Experiment Station, Urbana, Ill.
The character of the organic sulphur in coal.
Friability of Illinois coals.

Iowa Geological Survey, Des Moines, Iowa.
Weathering of Iowa coals.

State University of Iowa, Iowa City, Iowa.
Weathering properties of Iowa coals.
Chemical and thermal values of Iowa coals.

Lehigh University, Bethlehem, Pa.
Chemical constitution of bituminous coals.

Lehigh University, Department of Geology (in cooperation with the Anthracite Institute), Bethlehem, Pa.
The physical and chemical properties of Pennsylvania anthracite, including X-ray and microscopical studies, distillation, and physical measurements such as specific heats, electrical conductivity and coefficient of expansion.

Minneapolis General Electric Co., Minneapolis, Minn.
Ash-fusing characteristics of different coals.

Minnesota By-Product Coke Co., 1203 Van Buren Street, St. Paul, Minn.
Agglutinating value of coal.

University of Minnesota, School of Chemistry, Minneapolis, Minn.
The aqueous tension of lignite.

University of North Carolina, Chapel Hill, N. C.
Study of the inorganic sulphur in coal, including a fundamental study of the thermal decomposition of pyrite and the equilibrium between pyrite, sulphur, and ferrous sulphide.

University of North Dakota, Department of Chemistry, University Station, Grand Forks, N. Dak.
Investigation of benzene extracts of North Dakota lignites.

University of North Dakota, Division of Mines and Mining Experiments, University Station, Grand Forks, N. Dak.
The chemistry of lignite as shown by oxidation studies (electro-chemical,
Aqueous tension of lignite and other coals.
Specific heat of lignite and other coals.
The colloidal structure of lignite.
X-ray studies of lignite and coke.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Sampling of pulverized coal in coal-air streams.

Ohio Wesleyan University, Delaware, Ohio.
The relation of the ash-forming constituents in coal to the properties of coal, with special reference to Ohio coals.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Friability of anthracite.
A study of the physical and chemical properties of Pennsylvania bituminous coals, with particular reference to the utilization of the coals.
The condition of water in coal and its relationship to coal classification.

Pennsylvania State College, School of Mineral Industries (in cooperation with the Anthracite Institute), State College, Pa.
Properties of anthracite which will permit it to be used as a commercial carbon in the chemical and metallurgical industries.

Pennsylvania Water and Power Co., Lexington Street Building, Baltimore, Md.
Development and use of device for sampling coal deposits in bed of Susquehanna River.

University of Pittsburgh (in cooperation with the United States Bureau of Mines), Pittsburgh, Pa.
Chemistry of decay in relation to peat and coal formation.

Horace C. Porter, Consulting Chemist, 1833 Chestnut Street, Philadelphia, Pa.
Softening characteristics of coal and methods of testing therefor.

Rochester & Pittsburg Coal Co., Indiana, Pa.
Pulverization characteristics of coal from various parts of the Freeport seam.

Rose Polytechnic Institute, Terre Haute, Ind.
Marshall-Bird agglutinating test applied to Indiana coals.

Rutgers University, New Brunswick, N. J.
Microbiology of peat and formation of humic matter.

United States Bureau of Mines, Northwest Experiment Station, Seattle, Wash.
Physical and chemical properties of coal in relation to classification.

United States Bureau of Mines, Northwest Experiment Station (in cooperation with the University of Washington), Seattle, Wash.
Comparison of methods for determining the friability of coal.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Absorption of gases by coal.
A study of the plasticity of coal.
Development of analytical methods involving the extraction of coal with solvents.
Investigation of methods for separating ulmens and resistent plant residues in coal.
Comparison of permanganate and chlorate methods for determining the reactivity of coals.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with the American Society for Testing Materials and the Carnegie Institute of Technology), Pittsburgh, Pa.
Standardization of the agglutinating test of coal.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with the Carnegie Institute of Technology), Pittsburgh, Pa.
Occluded gases in coal.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with the Carnegie Institute of Technology and the University of Pittsburgh), Pittsburgh, Pa.
Chemistry of decay in relation to peat and coal formation.

United States Bureau of Mines, Southern Experiment Station, Tuscaloosa, Ala.
The classification of Alabama coals.

United States Geological Survey, Washington, D. C.
Character of coal in all deposits.

Vanderbilt University, Department of Geology, Nashville, Tenn.
Quality of the coals of the Western coal field of Kentucky and of the Northern coal field of Tennessee.

Virginia Agricultural & Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
Reclassification of Virginia coals.

University of Washington, Seattle, Wash.
Sampling of powdered coal.

University of Washington (in cooperation with the United States Bureau of Mines), Seattle, Wash.
Comparison of methods for determining the friability of coal.

West Virginia University, College of Engineering, Morgantown, W. Va.
Effects of high pressures on extraction products of bituminous coal.
Investigation of the physical and chemical properties of West Virginia coals.
Agglutinating and coking properties of some West Virginia coals.
Mechanical properties of West Virginia coals.

West Virginia University, Division of Industrial Sciences, Morgantown, W. Va.
Solvent extraction of bituminous coals.
Action of nitric acid on coal in anhydrous media.
Investigation of the physical and chemical properties of West Virginia coals, including friability, crushing strength, specific gravity, and water absorption.

Yale University, New Haven, Conn.
Development of methods for determining the grindability of coal.

Yale University, Department of Mechanical Engineering, Sheffield Scientific School, Mason Laboratory (in cooperation with the Anthracite Institute), 400 Temple Street, New Haven, Conn.
Ignition of anthracite coals.

III. Mining, Safety and Health

American Gas Association Testing Laboratory, 1032 East 62nd Street, Cleveland, Ohio.
Development of standard requirements.

Anthracite Institute (in cooperation with Pennsylvania State College), 90 West Street, New York, N. Y.
A new method of mining anthracite.

Atchison Topeka & Santa Fe Railway Co., Test Department, Crane and Branner Streets, Topeka, Kans.
Investigation of coals used on locomotives and in power plants.

Carnegie Institute of Technology (in cooperation with the United States Bureau of Mines), Schenley Park, Pittsburgh, Pa.
The effect of electric and magnetic fields on flame propagation.

Columbia University, New York, N. Y.
Roof action and subsidence.

Consolidated Gas Co. of New York, 4 Irving Place, New York, N. Y.
Nonquenching gas-range burner.
Safety controls for gas appliances.

Cutler Hammer (Inc.), 12th and St. Paul Street, Milwaukee, Wis.
Explosion-proof control equipment.

University of Illinois, Engineering Experiment Station, Urbana, Ill.
Coal-mine ventilation.
Accident studies of hand versus mechanical loading in coal mines.
Falls of roof and coal.
Coal mine haulage.

University of Kentucky, Department of Mining and Metallurgy, Lexington, Ky.
The design of a laboratory coal-dust explosion gallery.

Lafayette College, Easton, Pa.
Dust prevention in coal mines.

State University of Montana, Department of Geology, Missoula, Mont.
Occurrence, mining, and utilization of Montana coal and lignite.

Neville Chemical Co., Pittsburgh, Pa.
Toxicity of crude heavy solvent.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Friction at bends in air lines.
Effect of character of wire screens or gauzes in stopping flame in exploding gas-air mixtures.

Pennsylvania State College, School of Mineral Industries (in cooperation with the Anthracite Institute), State College, Pa.
A new method of mining anthracite.

Horace C. Porter, Consulting Chemist, 1833 Chestnut Street, Philadelphia, Pa.
Explosions of coal-dust and other solid materials.
Gas explosions.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Relative safety of different makes of trailing cable.
Electrostatic phenomena in mines.
Disposal of waste waters from mines.
Sealing abandoned mines and determining cause of alkalinity in others.
Relation between mining methods and accidents from falls of roof and coal.
Coal-mining methods and costs.
Ground movement and subsidence.
Occurrence of bumps in mines.
Rock-dusting of coal mines.
Determination of moisture-absorbing, wetting, and caking characteristics of material used for rock-dust barriers.
Behavior of different coal-dusts as regards propagation of flame.

United States Bureau of Mines - Continued.

Laboratory study of the inflammability of coal and other mineral dusts.
Laboratory investigation of effect of size of coal-dust on inflammability.
Compressibility and crushing strength of the Pittsburgh coal bed.
Effect of change in the quantity of dust present and in the strength of the source of ignition on the explosibility of coal-dust.
Physical tests of explosives to determine their permissibility for use in coal mines.
Collection and testing of field samples of permissible explosives.
Determination of the temperature attained by the products of detonation of explosives.
Development of analytical and testing methods for mine explosives.
Study of pressure waves produced by permissible explosives.
Safe handling and use of liquid-oxygen explosives.
Inflammability of gases and vapors.
Kinetics and mechanism of gaseous explosions.
The specific heats of gases at high temperatures by the explosion method.
Benzol poisoning.
Health hazards from methanol.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with Carnegie Institute of Technology), Pittsburgh, Pa.
The effect of electric and magnetic fields on flame propagation.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with the Western Electric Co.), Pittsburgh, Pa.
Explosive properties of acetone-air mixtures.

United States Bureau of Standards, Washington, D. C.
Investigation of the safety of utilization of gas, including the design and performance of gas appliances.

United States Public Health Service, Office of Industrial Hygiene and Sanitation, 16 Seventh Street, S.W., Washington, D. C.
Health of workers exposed to hard and soft coal-dusts.

Western Electric Co. (in cooperation with the United States Bureau of Mines), Chicago, Ill.
Explosive properties of acetone-air mixtures.

West Virginia University, College of Engineering, Morgantown, W. Va.
Coal-mining methods in West Virginia.

West Virginia University, Division of Industrial Sciences, Morgantown, W. Va.
Time studies on different phases of haulage operations and slope and shaft bottoms in West Virginia.
Typical haulage and slope and shaft-bottom layouts.
Relation between tons of coal produced per man and equipment in use per man.

IV. Cleaning, Preparation and Briquetting

University of Alabama (in cooperation with the United States Bureau of Mines), University, Ala.
Determination of the performance of selected washeries throughout various coal fields of Alabama.

American Smelting & Refining Co., 120 Broadway, New York, N. Y.
Coal and coke briquetting.

Battelle Memorial Institute (in cooperation with Ohio State University), 505 King Avenue, Columbus, O.
The betterment of Ohio coals.

Champlain Valley Lime Co., Winooski, Vt.
Elimination of sulphur from coal.

The Deister Concentrator Co., 901 Glasgow Avenue, Ft. Wayne, Ind.
Separation of stove-flats, cube nut, and pea coal on coal-washing tables.

The Dorr Co. (Inc.), 247 Park Avenue, New York, N. Y.
Classification and sizing of coal.

General Engineering Co., Salt Lake City, Utah, and 50 Broad Street, New York, N.Y.
Flotation and treatment of fine coal from coal-washing plants.

The Hoover Co., North Canton, Ohio.
Preparation of stoker fuel (cleaning and classification for regulation of particle size).

University of Illinois, Engineering Experiment Station, Urbana, Ill.
Preparation and washability tests of Illinois coals.

University of Illinois, Engineering Experiment Station, Industrial Chemistry Division, Urbana, Ill.
Removal of sulphur from coal.

University of Illinois, Engineering Experiment Station, Chemical Division (in cooperation with the Utilities Research Commission (Inc.)), Urbana, Ill.
Removal of impurities from coal.

International Combustion Engineering Corporation, 200 Madison Avenue, New York, N. Y.
Drying and pulverizing coal.

Iowa Geological Survey, Des Moines, Iowa.
Washing of Iowa coals.

Iowa State College of Agriculture and Mechanic Arts, Iowa Engineering Experiment Station, Ames, Iowa.
Washing Iowa coals.

State University of Iowa, Department of Chemical Engineering, Iowa City, Iowa.
Washing of Iowa coals.

James Ore Concentrator Co., 35 East Runyon Street, Newark, N. J.
Preparation and beneficiation of coal.

University of Kentucky, Department of Mining and Metallurgy, Lexington, Ky.
Briquetting of bituminous slack coal, using a cold process with a non-volatile organic binder.

Koppers-Rheolaveur Co., 1150 Koppers Building, Pittsburgh, Pa.
Coal preparation and the float-and-sink test applied to coal preparation.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Separation of ash from high-ash coal.
Preparation of briquettes from high-ash coal.
Study of various briquetting methods.

University of Minnesota, Minneapolis, Minn.
Grinding and preparation of dried lignite for powdered fuel purposes.

University of Minnesota, School of Chemistry, Minneapolis, Minn.
The drying of lignite without disintegration.

University of North Carolina, Chapel Hill, N. C.
Elimination of sulphur from North Carolina coals.

University of North Dakota, Division of Mines and Mining Experiments, University Station, Grand Forks, N. Dak.
Drying of lignite without disintegration, including the study of the mechanism and the physical properties of the processed lignite.

Ohio State University, Engineering Experiment Station (in cooperation with Battelle Memorial Institute), Columbus, Ohio.
The betterment of Ohio coals.

Oliver United Filters (Inc.), Federal Reserve Bank Building, San Francisco, Calif.
Dewatering and drying of fine coals.

Pacific Coast Coal Co., Seattle, Wash.
Clarification of water from coal washeries.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Nature of the action of selective agents in cleaning coal by froth flotation.

Horace C. Porter, Consulting Chemist, 1833 Chestnut Street, Philadelphia, Pa.
Briquetting of low-grade and other coals.

Portland Gas and Coke Company, Public Service Building, Portland, Oreg.
Improving durability of fuel briquets made from carbon residue from oil gas manufacture.

Roanoke College, Salem, Va.
Factors influencing the preparation of coal briquettes.

Rodman Chemical Co., Verona, Pa.
Briquetting of coals.

Foster D. Snell, Consulting Chemist, 130 Clinton Street, Brooklyn, N. Y.
Preparation of coal briquettes with suitable waterproof properties without the use of tar or smoke-producing binder.

University of Texas, Bureau of Industrial Chemistry, Austin, Tex.
Improvement of lignite as a fuel.

United States Bureau of Mines, Northwest Experiment Station (in cooperation with the University of Washington), Seattle, Wash.
Washability of fine sizes of coal.
Difficulties in cleaning fine coal by froth flotation.
Separation effected by pneumatic coal-washing tables.

United States Bureau of Mines, Southern Experiment Station (in cooperation with the University of Alabama), Tuscaloosa, Ala.
Determination of performance of selected washeries throughout various coal fields of Alabama.

Utilities Research Commission (Inc.), (in cooperation with the University of Illinois), Room 522, 72 West Adams Street, Chicago, Ill.
Removal of impurities from coal.

University of Washington (in cooperation with the United States Bureau of Mines), Seattle, Wash.
Washability of fine sizes of coal.
Difficulties in cleaning coal by froth flotation.
Separation effected by pneumatic coal-washing tables.

West Virginia University, College of Engineering, Morgantown, W. Va.
Determination of the possibility of preparing the high-sulphur and high-ash coals of northern West Virginia to render them available for the manufacture of by-product coke.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
Separating high and low ash anthracite coal, using the principle of attraction and repulsion by electric charges.

V. Storage, Transportation, Weathering, and Spontaneous Combustion

Consolidated Gas, Electric Light & Power Co., Baltimore, Md.
Effect on concrete of acid water from stored bituminous coal.

Detroit Edison Co., 2000 Second Avenue, Detroit, Mich.
Effect of sulphur water on concrete.

Iowa Geological Survey, Des Moines, Iowa.
Weathering of Iowa coals.
Heating of Iowa coals in storage.
Breakage of Iowa coal in transportation.

State University of Iowa, Iowa City, Iowa.
Rate of heating of Iowa coals in storage.
Weathering properties of Iowa coals.

State University of Iowa, Department of Chemical Engineering, Iowa City, Iowa
Dusting and slacking tendencies of Iowa coals.
Storage of Iowa coal.

Lehigh Portland Cement Co., Young Building, Allentown, Pa.
Effect of storage on properties of coal.

University of North Dakota, Division of Mines and Mining Experiments, University Station, Grand Forks, N. Dak.
Spontaneous combustion of lignite.

Horace C. Porter, Consulting Chemist, 1833 Chestnut Street, Philadelphia, Pa.
Improvement of methods for storage of coal.
Spontaneous combustion in stored coal and other materials.

Purdue University, Engineering Experiment Station, Lafayette, Ind.
Causes of spontaneous combustion of stored coal.

VI. Combustion, Furnaces, and Smoke Abatement (including gas)

(Problems on boiler-water and its treatment are listed under Section C-XIII. Problems on corrosion are listed under Section D-V.)

American Engineering Co., Philadelphia, Pa.
- Investigation of automatic dampers for controlling air flow through the fuel bed.
- Effect of high-temperature preheated air on the softening of coal.
- Effect of high-temperature preheated air on the burning and wasting away of stoker parts.
- Effect of high-temperature preheated air on expansion of stoker parts.

American Gas Association (in cooperation with the American Gas Furnace Co. and Mr. Robert Guthrie), 420 Lexington Avenue, New York, N. Y.
- Application of gas heat to brass melting.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Consolidated Gas Co. of New York), 420 Lexington Avenue, New York, N. Y.
- Applying gas-air jet combustion to bituminous coal.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Consolidated Gas Co. of New York and the C. M. Kemp Manufacturing Co.), 420 Lexington Avenue, New York, N. Y.
- Development of immersion stereotype melting equipment.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the C. M. Kemp Manufacturing Co.), 420 Lexington Avenue, New York, N.Y.
- Development of gas immersion heating elements for galvanizing tanks.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the University of Michigan), 420 Lexington Avenue, New York, N. Y.
- The application of heat to core baking.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the University of Michigan and the Surface Combustion Corporation), 420 Lexington Avenue, New York, N. Y.
- The utilization of gas for forging.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the National Machine Works), 420 Lexington Avenue, New York, N. Y.
- Improvement of oven-furnace design.

American Gas Association, Committee on Industrial Gas Research (in cooperation with Rutgers University), 420 Lexington Avenue, New York, N. Y.
- Improving practices and efficiencies in the utilization of artificial gas in the firing of ceramic wares.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Standard Gas Equipment Corporation and the Surface Combustion Corporation), 420 Lexington Avenue, New York, N. Y.
Development of refractory diaphragm burners.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation), 420 Lexington Avenue, New York, N.Y.
Development of large-sized short tunnel burners.

American Gas Association, Testing Laboratory, Cleveland, Ohio.
The elimination of noises in industrial gas burners.
Burning gas with preheated air.
Fundamentals of combustion space requirements in industrial gas furnaces.
Utilization characteristics of butane-air and butane-city gas mixtures.
Ignition velocities of various fuel gases.
Effects of external factors upon the efficiency of gas-fired steam and hot-water radiators.
Development of standard requirements.

American Gas Furnace Co. (in cooperation with the American Gas Association and Mr. Robert Guthrie), Elizabeth, N. J.
Application of gas heat to brass melting.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Combustion and efficient use of fuel in heating furnaces.

American Society of Heating and Ventilating Engineers, Research Laboratory, 4800 Forbes Street, Pittsburgh, Pa.
Study of economical and otherwise satisfactory utilization of coal in heating buildings.
Research in the improvement of methods of testing, and standardization of applicances for heating buildings.

American Society of Heating and Ventilating Engineers (in cooperation with the Carnegie Institute of Technology), 4800 Forbes Street, Pittsburgh, Pa.
Sizes of steam pipes in low-temperature heating systems.

American Society of Mechanical Engineers (in cooperation with the University of Oklahoma), 29 West 39th Street, New York, N. Y.
The efficiencies of boilers used in drilling a rotary-drilled oil well.

American Society of Mechanical Engineers (in cooperation with the United States Bureau of Mines), 29 West 39th Street, New York, N. Y.
Removal of ash as molten slag from powdered-coal furnaces.

Anthracite Institute Laboratory, Primos, Pa.
General testing and development in connection with the combustion of anthracite, and in connection with the design and operation of anthracite-burning equipment.

Anthracite Institute (in cooperation with Lehigh University), 90 West Street, New York, N. Y.
Combustion tests of Pennsylvania anthracite.

Anthracite Institute (in cooperation with Lehigh University, Pennsylvania State College, and Yale University), Primos, Pa.
Study of equipment for use of anthracite coal.

Armour Institute of Technology, 3300 Federal Street, Chicago, Ill.
Disposal of coal ash when burning powdered coal.

Atchison, Topeka & Santa Fe Railway Co., Test Department, Crane and Branner Streets, Topeka, Kans.
Investigation of coals used on locomotives and in power plants.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Large-scale laboratory study of the mechanism of combustion of pulverized fuel and the effect of fineness, moisture, and other factors on the process.

Brooklyn Edison Co. (Inc.), 380 Pearl Street, Brooklyn, N. Y.
Study of caking characteristics of eastern and southern coals on underfeed stokers.

Bryant Heater & Manufacturing Co., 17825 St. Clair Avenue, Cleveland, Ohio.
General problems connected with utilization of manufactured gas in building heating.

Buffalo Forge Co., 490 Broadway, Buffalo, N. Y.
Investigation of dry and wet centrifugal scrubbers for use in boiler plants and chemical processes.

California Agricultural Experiment Station, College of Agriculture, Davis, Calif.
Study of orchard heaters, including weighing smoke per unit volume of gases emitted and correlating with fuel consumption rate.

Carnegie Institute of Technology, Coal Research Laboratory, Schenley Park, Pittsburgh, Pa.
Mechanism of combustion of solid fuels.

Carnegie Institute of Technology, College of Industries, Schenley Park, Pittsburgh, Pa.
Performance of low-pressure steam-heating boilers.
Performance of unit heaters.

Carnegie Institute of Technology (in cooperation with the American Society of Heating and Ventilating Engineers), Schenley Park, Pittsburgh, Pa.
Sizes of steam pipes in low-temperature heating systems.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
The utilization of manufactured gas for economically and safely heating and humidifying the home under controlled conditions.

Chespeake and Ohio Railway (in cooperation with the University of Kentucky), Richmond, Va.
The suitability of coals along the line of the Chespeake and Ohio Railway for domestic purposes, especially their adaptability for use in small stokers.
Observations of smoke densities, using an electric eye.

Columbia University, Department of Mechanical Engineering, New York, N. Y.
Combustion and furnaces with burners, stokers, and other appliances for heat release from fuels.
Heat transfer processes and apparatus.

Commercial Testing and Engineering Co., 360 North Michigan Avenue, Chicago, Ill.
Combustion of coal.

Commonwealth Edison Co., 72 West Adams Street, Chicago, Ill.
Fly-ash and sulphur-fume elimination from flue gases.

Consolidated Gas Co. of New York, 4 Irving Place, New York, N. Y.
Nonquenching gas-range burner.
Safety controls for gas appliances.

Consolidated Gas Co. of New York, Laboratories (in cooperation with the American Gas Association), 4 Irving Place, New York, N. Y.
Applying gas-air jet combustion to bituminous coal.

Consolidated Gas Co. of New York, Laboratories (in cooperation with the American Gas Association and the C. M. Kemp Manufacturing Co.), 4 Irving Place, New York, N. Y.
Development of immersion stereotype melting equipment.

Corning Glass Works, Corning, N. Y.
More effective utilization of gas and coal in the manufacture of glass.
Furnace design.

Detroit Edison Co., 2000 Second Avenue, Detroit, Mich.
Furnace gas compositions and temperatures in underfeed stoker-fired boilers and their effect on boiler settings.
The development of uses for pulverized coal ash.

Detroit Edison Co. (in cooperation with the University of Michigan), 2000 Second Avenue, Detroit, Mich.
Spectrographic analysis of gas.

Detroit Edison Co. (in cooperation with the Superheater Co. and Yale University), 2000 Second Avenue, Detroit, Mich.
Radiation, heat absorption, and progress of combustion.

University of Dubuque, 2050 Delhi Street, Dubuque, Iowa.
Fusion point of the ash of various coals and the suitability of the coal for use in firing furnaces with stokers, with special attention to screenings.

C. A. Dunham Co., Marshalltown, Iowa.
Improvement in heating systems for buildings.

Erie City Iron Works, Erie, Pa.
Pulverizing and firing coal in boiler furnaces.

Frost Research Laboratory (Inc.), 1326 Markely Street, Norristown, Pa.
Combustible characteristics of solid fuels.
Development of domestic stoker to burn smallest-sized anthracite and coke.

Fuel Engineering Co. of New York, 116 East 18th Street, New York, N. Y.
Grindability of coal for pulverizer service.
The mechanism of combustion of coal in suspension.

Mr. Robert Guthrie, Consulting Metallurgist (in cooperation with the American Gas Association and the American Gas Furnace Co.), 122 South Michigan Avenue, Chicago, Ill.
Application of gas heat to brass melting.

Hagan Corporation, 304 Ross Street, Pittsburgh, Pa.
Combustion control.

Harvard University, The Harvard Engineering School, Cambridge, Mass.
Smoke prevention and dust catching.
Effects of dust, fumes, and smoke on men and animals.

University of Illinois, Engineering Experiment Station, Urbana, Ill.
Method of removing harmful and corrosive constituents from the flue gases of a power plant.
Performance studies of a stoker-boiler unit.

University of Illinois (in cooperation with the Utilities Research Commission (Inc.)), Urbana, Ill.
Stack gases and their purification.

University of Illinois, Engineering Experiment Station, Department of Mechanical Engineering (in cooperation with the National Warm Air Heating Association), Urbana, Ill.
Performance of warm-air furnaces and furnace heating systems.

International Combustion Engineering Corporation, 200 Madison Avenue, New York, N. Y.
Combustion of fuels.
Heat transfer from burning fuel and products of combustion to water-cooled surfaces.

Iowa State College of Agriculture and Mechanic Arts, Engineering Experiment Station, Ames, Iowa.
Burning pulverized Iowa coal.
Study of the economy of a gas-fired boiler for domestic heating.

Johns Hopkins University, Baltimore, Md.
A study of chimney performance.

Johns Hopkins University, Department of Mechanical Engineering, Baltimore, Md.
Study of the economic distribution of heating surface in large boilers, between water walls, boiler surface, economizer surface, and air preheater surface.

City of Kalamazoo, Kalamazoo, Mich.
Study of cinder, soot, and ash deposits in the city of Kalamazoo.

Kansas State Agricultural College, Department of Mechanical Engineering, Manhattan, Kans.
The use of oil and gas as fuel in house-heating boilers.

C. M. Kemp Manufacturing Co. (in cooperation with the American Gas Association), Baltimore, Md.
Development of gas immersion heating elements for galvanizing tanks.

C. M. Kemp Manufacturing Co. (in cooperation with the American Gas Association and the Consolidated Gas Co. of New York), Baltimore, Md.
Development of immersion stereotype melting equipment.

University of Kentucky (in cooperation with the Chespeake and Ohio Railway), Lexington, Ky.
The suitability of coals along the line of the Chespeake and Ohio Railway for domestic purposes, especially their adaptability for use in small stokers.
Observation of smoke densities, using an electric eye.

Kewanee Boiler Corporation, Kewanee, Ill.
Performance characteristics of heating boilers.

Lauks Laboratories (Inc.), 314 Maritime Building, Seattle, Wash.
Powdered-coal burning.
Stoker design.

Lehigh Portland Cement Co., Young Building, Allentown, Pa.
Effect of coal ash on Portland cement composition.

Lehigh University, Department of Geology (in cooperation with the Anthracite Institute), Bethlehem, Pa.
Combustion tests of Pennsylvania anthracite.

Lehigh University (in cooperation with Anthracite Institute Laboratory, Pennsylvania State College, and Yale University), Bethlehem, Pa.
Study of equipment for use of anthracite coal.

Massachusetts Institute of Technology, Department of Fuel and Gas Engineering, Cambridge, Mass.
The mechanism of the combustion of solid carbon.
Heat transmission in furnaces.
Industrial furnace design.

Massachusetts Institute of Technology (in cooperation with the National Research Council), Cambridge, Mass.
Measurement of total radiation from hot gases.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Air pollution in the Pittsburgh area.

University of Michigan, Department of Chemical Engineering, Ann Arbor, Mich.
Development of high temperature heating by means of high boiling organic vapors.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Methods of heating asphalt.
Utilization of pulverized-fuel ash.

University of Michigan, Department of Mechanical Engineering, Ann Arbor, Mich.
Study of the cinder, soot, and ash deposits in a manufacturing city.

University of Michigan (in cooperation with the Detroit Edison Co.), Ann Arbor, Mich.
Spectrographic analysis of gas.

University of Michigan, Department of Engineering Research (in cooperation with the American Gas Association), Ann Arbor, Mich.
The application of heat to core baking.

University of Michigan, Department of Engineering Research (in cooperation with the American Gas Association and the Surface Combustion Co.), Ann Arbor, Mich.
The utilization of gas for forging.

University of Michigan, Department of Engineering Research (in cooperation with the Utilities Research Commission (Inc.)), Ann Arbor, Mich.
Brass melting by city gas.

Minneapolis-Honeywell Regulator Co., Wabash, Ind.
Temperature control in furnaces.

University of Minnesota, Minneapolis, Minn.
Grinding and preparation of dried lignite for powdered-fuel purposes.

Mississippi Valley Research Laboratories (Inc.), 660 South 18th Street, St. Louis, Mo.
Process of combustion of coke in foundry cupolas.

State University of Montana, Department of Geology, Missoula, Mont.
Occurrence, mining, and utilization of Montana coal and lignite.

National Building Units Corporation (in cooperation with the National Cinder Concrete Products Association and the United States Bureau of Standards), 122 East 42nd Street, New York, N. Y.
Cinders or boiler ashes as an aggregate for concrete.

National Cinder Concrete Products Association (in cooperation with the United States Bureau of Standards and the National Building Units Corporation), 1600 Arch Street, Philadelphia, Pa.
Cinders or boiler ashes as an aggregate for concrete.

National Machine Works (in cooperation with the American Gas Association), 1559 Sheffield Avenue, Chicago, Ill.
Improvement of oven furnace design.

National Research Council, Committee on Heat Transmission, 2101 B Street, N.W., Washington, D. C.
Measurement of radiation from nonluminous gases and flames.

National Research Council, Committee on Heat Transmission (in cooperation with the Massachusetts Institute of Technology), 2101 B Street, N.W., Washington, D. C.
Measurement of total radiation from hot gases.

National Warm Air Heating Association (in cooperation with the University of Illinois), 174 East Long Street, Columbus, Ohio.
Performance of warm-air furnaces and furnace heating systems.

New York Edison System, 4 Irving Place, New York, N. Y.
Elimination of cinders from stacks by improved collecting device.
Investigation of possible hydrocarbon stack loss.
Effect of introducing overfire air over each retort of underfeed stoker.
Study of improvement in operation of stoker-fired boilers by changing relation of forced and induced draft.

Norfolk and Western Railway, Roanoke, Va.
Tests of automatic domestic stokers with various coals produced along the line of the Norfolk and Western Railway.

University of North Dakota, University Station, Grand Forks, N. Dak.
Lignite combustion equipment, including stokers for domestic use.

University of North Dakota, Division of Mines and Mining Experiments, University Station, Grand Forks, N. Dak.
Combustion of pulverized lignite.
Boiler tests with stoker and grate equipment burning lignite.
Testing of domestic stoker equipment burning lignite.

Northern States Power Co., 15 South 5th Street, Minneapolis, Minn.
Combustion of coal.
Determination of fusibility of coal ash and interpretation of results in terms of furnace operation.

The Ohio Brass Co., Mansfield, Ohio.
Use of pulverized coal in metallurgical and boiler furnaces.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Tests of the utilization of Ohio coals in boiler operation.

Ohio State University, Engineering Experiment Station (in cooperation with the United States Bureau of Mines), Columbus, Ohio.
The application of stokers to ceramic kilns.
A study of the burning characteristics of fuels in ceramic kilns.

University of Oklahoma, School of Mechanical Engineering (in cooperation with the American Society of Mechanical Engineers), Norman, Okla.
The efficiencies of boilers used in drilling a rotary-drilled oil well.

Oregon State Agricultural College, Department of Mechanical Engineering, Corvallis, Oreg.
Study of the burning of fuels in a furnace wherein pressure is maintained at about 7 atmospheres.
Introduction into boilers of make-up steam instead of make-up water.

Pacific Coast Coal Co., Seattle, Wash.
Utilization of high combustible waste.

Pennsylvania-Ohio Power & Light Co., Toronto Station, Youngstown, Ohio.
Investigation of factors influencing removal of ash as molten slag from furnaces burning pulverized coal.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Combustibility and reactivity of coke in the blast furnace.
A study of the physical and chemical properties of Pennsylvania bituminous coals with particular reference to the utilization of the coals.

Pennsylvania State College (in cooperation with Anthracite Institute, Lehigh University and Yale University), State College, Pa.
Study of equipment for use of anthracite coal.

Pennsylvania Water & Power Co., Lexington Street Building, Baltimore, Md.
Studies on minimizing fly-ash from boilers and dust from coal pulverizing.
Dust-collection tests on coal-pulverizing mills and powdered-coal furnaces.

Peoples Gas Light & Coke Co., 122 South Michigan Avenue, Chicago, Ill.
Fundamental processes of gaseous combustion.

Pittsburgh Plate Glass Co., Window Glass Research Department, Mt. Vernon, Ohio.
Use of producer gas in window-glass melting.

Pittsburgh Testing Laboratory, Pittsburgh, Pa., and New York, N. Y., and elsewhere.
Coke plant smoke injury.

Polytechnic Institute of Brooklyn, Department of Mechanical Engineering, Brooklyn, N. Y.
Study of smoke abatement in the metropolitan district.
Comparative tests of house-heating boilers using coal, oil, and gas.
Comparative tests of automatic temperature controls.
Study and comparative tests of gas-burner venturis.

Horace C. Porter, Consulting Chemist, 1833 Chestnut Street, Philadelphia, Pa.
Nuisances and risks from the burning of powdered coal and other fuels.
Mechanism of the burning of coal on mechanical stokers.
Burning characteristics of coke, semicoke, coals, and other fuels.

Public Service Electric & Gas Co., Newark, N. J.
Tests to determine weight of solids carried by flue gas from underfeed stoker and loss of efficiency due to combustible matter in soot.

Purdue University, Engineering Experiment Station, Lafayette, Ind.
Study of small stokers utilizing Indiana coal.

Purdue University, School of Chemical Engineering, Lafayette, Ind.
Study of possibilities for utilization of fly-ash or flue-dust from powdered coal.

Purdue University, Engineering Experiment Station (in cooperation with the Indiana Gas Association), Lafayette, Ind.
Comparative heating value of gas, oil, coal, and coke in house heating.

Research Corporation, Bound Brook, N. J., and Washington, D. C.
Elimination of sulphur fumes from combustion gases.
Utilization of pulverized-fuel ash.

W. S. Rockwell Co., South Church Street, New York, N. Y.
Better methods of utilizing coal and gas for industrial heating operations in the metal, ceramic, and chemical industries through improved furnace design.

Rodman Chemical Co., Verona, Pa.
Pulverizing of coal.

Rutgers University (in cooperation with the American Gas Association), New Brunswick, N. J.
Improving practices and efficiencies in the utilization of artificial gas in the firing of ceramic wares.

St. Louis, Citizens Smoke Abatement League of, St. Louis, Mo.
Photographic recording of smoke.

Singmaster & Breyer, Metallurgical and Chemical Engineers, Room 2831, 420 Lexington Avenue, New York, N. Y.
Anthracite-dust as a boiler fuel.

South Dakota State School of Mines, Rapid City, S. Dak.
The utilization of lignite.

Standard Gas Equipment Corporation (in cooperation with the American Gas Association and the Surface Combustion Corporation), 18 East 41st Street, New York, N. Y.
Development of refractory diaphragm burners.

Standard Oil Development Co., 26 Broadway, New York, N. Y.
Application of fuels to household and industrial heating plants and gas manufacture.

Stevens Institute of Technology, Hoboken, N. J.
Study of atmospheric contamination, its sources as relating to fuel combustion, its effect, both mechanical and chemical.

Stitzer and Waddell, 1540 Nicholas Building, Toledo, Ohio.
Adaptation of gas-burner equipment for use with various fuel gases.

Superheater Co. (in cooperation with the Detroit Edison Co. and Yale University), 17 East 42nd Street, New York, N. Y.
Radiation, heat absorption, and progress of combustion.

Surface Combustion Corporation, 2375 Dorr Street, Toledo, Ohio.
Applications of new methods of combustion to metallurgical operations.

Surface Combustion Corporation (in cooperation with the American Gas Association), 2375 Dorr Street, Toledo, Ohio.
Development of large-sized short-tunnel burners.

Surface Combustion Corporation (in cooperation with the American Gas Association and the University of Michigan), 2375 Dorr Street, Toledo, Ohio.
The utilization of gas for forging.

Surface Combustion Corporation (in cooperation with the American Gas Association and the Standard Gas Equipment Corporation), 2375 Dorr Street, Toledo, Ohio.
Development of refractory diaphragm burners.

United Electric Light & Power Co., Sherman Creek Station, New York, N. Y.
Determination of efficiency of bleeder-type Cottrell precipitation on stoker and pulverized-fuel-fired boilers.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Tests of secondary air mixing devices for domestic furnaces.
Determination of relative availability of cokes for use in domestic-heating furnaces.
Effect of preheated air on fuel-bed characteristics.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with the American Society of Mechanical Engineers), Pittsburgh, Pa.
Removal of ash as molten slag from powdered-coal furnaces.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with the Ohio State University), Pittsburgh, Pa.
A study of the burning characteristics of fuels in ceramic kilns.
The application of stokers to ceramic kilns.

United States Bureau of Standards, Washington, D. C.
Investigation of the safety and efficiency of utilization of gas.
Standards for gas service. The best practice and the requirements made by municipal and state regulatory bodies in the manufacture, distribution, metering, and utilization of fuel gases by public utilities.

United States Bureau of Standards (in cooperation with the National Building Units Corporation and the National Cinder Concrete Products Association), Washington, D. C.
Cinders or boiler ashes as an aggregate for concrete.

Utah Coal Producers Association (in cooperation with the University of Utah), 709 Ezra Thompson Building, Salt Lake City, Utah.
Study of the adaptability of small overfeed stokers for firing brick kilns.
Tests of McVey combustion chamber.

University of Utah, Engineering Experiment Station (in cooperation with the Utah Coal Producers Association), Salt Lake City, Utah.
Study of the adaptability of small over feed stokers for firing brickkilns.
Tests of McVey combustion chamber.

Utilities Research Commission (Inc.) (in cooperation with the University of Illinois), 72 West Adams Street, Chicago, Ill.
Stack gases and their purification.

Utilities Research Commission (Inc.) (in cooperation with the University of Michigan), 72 West Adams Street, Chicago, Ill.
Brass melting by city gas.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
The design of a more efficient residence furnace for use with a stoker.
The development of a better domestic stoker for lignite coals.
Development of an improved hot-water furnace for domestic use.

Washington University, St. Louis, Mo.
Quantitative measurement of atmospheric smoke pollution.

University of Washington, Mechanical Engineering Department, Seattle, Wash.
Selection of Western Washington coals suitable for powdered coal installations.

West Virginia University, College of Engineering, Morgantown, W. Va.
Design and investigation of automatic feeding devices for residence-heating boilers.

West Virginia University, Division of Industrial Sciences, Morgantown, W. Va.
A study of the mechanism of the kinetics of the homogeneous oxidation of hydrocarbons.
The mechanism of combustion of coal. I. Combustion of pulverized coal. II. Combustion of lump coal. (A theoretical study of the kinetics of the combustion of coal under conditions approximating those existing in industrial furnaces.)

Yale University, Department of Mechanical Engineering, Sheffield Scientific School, Mason Laboratory, 400 Temple Street, New Haven, Conn.
Performance of low-pressure heating boilers using various fuels.
The combustion process in power boiler furnaces.
Performance of pulverized coal in marine steam boilers.
Economic performance of furnaces, and boilers, radiators, heat cabinets, hotblast heaters, etc.

Yale University (in cooperation with Anthracite Institute, Lehigh University, and Pennsylvania State College), New Haven, Conn.
Study of equipment for use of anthracite coal.

Yale University (in cooperation with the Detroit Edison Co. and the Superheater Co.), New Haven, Conn.
Radiation, heat absorption, and progress of combustion.

VII. Carbonization

University of Alabama, School of Chemistry, Metallurgy and Ceramics, University Post Office, Ala.
Low-temperature carbonization (575°F.) of Alabama coals (using 30-pound samples) to determine yield of char, tar, and gas.

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.
Low-temperature carbonization of coal.

American Gas Association (in cooperation with the United States Bureau of Mines), 420 Lexington Avenue, New York, N. Y.
Development of methods for determining gas and coke making properties of coal.

Babcock and Wilcox, New York, N. Y.
Low-temperature carbonization of coal.

Battelle Memorial Institute (in cooperation with the Ohio State University), 505 King Avenue, Columbus, Ohio.
The continuous carbonization of coarsely powdered coal (White process) in a 1-ton vertical retort with recovery and analysis of the products.

Carnegie Institute of Technology, Coal Research Laboratory, Pittsburgh, Pa.
Mechanism of coking.
Influence of heating rate and final temperature on properties of derivatives of coal.
Energy relations involved in coking.

Colorado College, Colorado Springs, Colo.
Determination of quality and quantity of gas, coke, and by-products obtained in the low-temperature carbonization of Colorado sub-bituminous coals.

Columbia University, New York, N. Y.
Study of gases and tar vapors evolved from coal at successively higher temperatures and the thermal decomposition of the same.

Combustion Utilities Corporation, 60 Wall Street, New York, N. Y.
Low-temperature carbonization of coal.

Continental Industrial Engineers (Inc.), 201 North Wells Street, Chicago, Ill.
Low-temperature distillation of coal.

Crowley Tar Products Co., 415 Lexington Avenue, New York, N. Y.
Carbonization of bituminous coals, especially at low temperatures.

The Detroit Testing Laboratory, 554 Bagley Avenue, Detroit, Mich.
Low-temperature distillation of coal.

Dittlinger-Crow Process Co., New Braunfels, Tex.
Low-temperature carbonization.
Destructive distillation of fuels.

Du Pont Ammonia Corporation, Wilmington, Del.
Coke production.

Internation Combustion Engineering Corporation, 200 Madison Avenue, New York, N. Y.
Carbonization of coal at low temperatures.

Iowa Geological Survey, Des Moines, Iowa.
Coking of Iowa coals.

Iowa State College of Agriculture and Mechanic Arts, Iowa Engineering Experiment Station, Ames, Iowa.
Destructive distillation of Iowa coal.

State University of Iowa, Department of Chemical Engineering, Iowa City, Iowa.
Carbonization of Iowa coals.

University of Kentucky, Department of Mines and Metallurgy, Lexington, Ky.
The low-temperature carbonization of carbonaceous materials with special reference to oil shales, and cannel and bituminous coals.

Louisville Cement Corporation, 315 Guthrie Street, Louisville, Ky.
Low-temperature carbonization of eastern Kentucky coals.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Coke fellowship.

University of Michigan, Department of Chemical Engineering, Ann Arbor, Mich.
Instantaneous carbonization of coal.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Special processes of coke manufacture.
Carbonization of crushed coal.

University of Minnesota, Minneapolis, Minn.
High and low temperature distillating of lignite and an investigation of the products obtained.

National Electric Heating Co., Incorporated, 154 Nassau Street, New York, N.Y.
Low-temperature carbonization as applied to pretreatment of pulverized coal in central station practice.

University of North Dakota, Division of Mines and Mining Experiments, University Station, Grand Forks, N. Dak.
Coking of lignite, including a study of the effect of inorganic salts on the process.

Ohio State University, Engineering Experiment Station (in coöperation with Battelle Memorial Institute), Columbus, Ohio.
Vertical retort tests of the White process of carbonization.

The Pawtucket Gas Co., Pawtucket, R. I.
Use of gas oil in the manufacture of coal gas.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Low-temperature distillation of Pennsylvania coals.

University of Pittsburgh, Pittsburgh, Pa.
Coal distillation.

Horace C. Porter, Consulting Chemist, 1833 Chestnut Street, Philadelphia, Pa.
Mechanism of coal carbonization.
Processing of low-grade and other coals by carbonization.

The United Gas Improvement Co., Physical Laboratory, 3101 Passyunk Avenue, Philadelphia, Pa.
Methods of carbonization.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
The plastic state of coal during coking.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with the American Gas Association), Pittsburgh, Pa.
Development of methods for determining gas and coke making properties of coal.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
The coking of semianthracite coal of Virginia.

Weiss and Downs (Inc.), 50 East 41st Street, New York, N. Y.
Low-temperature carbonization of coal.
The economics of coal carbonization.

West Virginia University, Division of Industrial Sciences, Morgantown, W. Va.
Carbonization of West Virginia coals.

Yale University, Chemical Engineering Department, Sterling Chemistry Laboratory, 225 Prospect Street, New Haven, Conn.
Carbonization of bituminous-coal briquets to obtain a product of high specific gravity.
Studies of behavior of coals under carbonizing conditions.
Manufacture of artificial anthracite from bituminous coal.

VIII. Carbonization Products

(Problems on paints in general are listed under Section C-IX)

University of Alabama, University, Ala.
Composition and utilization of tars.

American Gas Association, 420 Lexington Avenue, New York, N. Y.
Commercial refrigeration with gas.

American Gas Association, Testing Laboratory, Cleveland, Ohio.
Characteristics of mixed gases.

American Gas Association (in cooperation with Johns Hopkins University), 420 Lexington Avenue, New York, N. Y.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Consolidated Gas Co. of New York, the Dallas Gas Co., the Peoples Gas Light & Coke Co., and the Silica Gel Corporation), 420 Lexington Avenue, New York, N. Y.
Development of gas-operated house-cooling and air-conditioning equipment.

American Petroleum Institute (in cooperation with the United States Geological Survey), 250 Park Avenue, New York, N. Y.
The determination of the thermal conductivity of gases and its application to the precise analysis of gases.

American Railway Engineering Association (in cooperation with the American Society for Testing Materials, the American Wood Preservers' Association, and the United States Bureau of Standards), 431 South Dearborn Street, Chicago, Ill.
Determination of the expansion factor of creosote oil.

American Society of Refrigerating Engineers (in cooperation with the United States Bureau of Standards), 37 West 39th Street, New York, N. Y.
Thermal properties of ammonia and other refrigerants.

American Society for Testing Materials (in cooperation with the American Railway Engineering Association, the American Wood Preservers' Association, and the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Determination of the expansion factor of creosote oil.

American Tar Products Co., Koppers Building, Pittsburgh, Pa.
Improvement of coal-tar products for road building.
Improvements in creosote and other wood preservatives.
The development of new uses and the extension of existing uses for pitch.
Investigation of methods of coking pitch.
Investigation of the recovery and utilization of tar acids.
The general utilization of coal-tar products.

American Wood Preservers' Association (in cooperation with the American Society for Testing Materials, the American Railway Engineering Association, and the United States Bureau of Standards), 228 North La Salle Street, Chicago, Ill.
Determination of the expansion factor of creosote oil.

Armour Institute of Technology, 3300 Federal Street, Chicago, Ill.
Removal of sulphur compounds from coal gas by means of an alkaline arsenite solution and the recovery of by-products from this solution.

The Barrett Co., 40 Rector Street, New York, N. Y.
Benzol and tar acid refining.
Production of naphthalene, anthracene, acenaphthene and other hydrocarbons.
Improvements in road materials and rubber softeners.
Coal-tar products for pipe-line protection, paints, and plastic cements.

The Brooklyn Union Gas Co., 191 St. James Place, Brooklyn, N. Y.
Cracking problems of gas oil.

Samuel Cabot (Inc.), 141 Milk Street, Boston, Mass.
Effect of time and temperatures on the compounds formed by the distillation of tars.
Improvement in yield and grade of lampblack (from coal-tar distillation) by contact catalysts and by temperature control.

Carnegie Institute of Technology (in cooperation with the United States Bureau of Mines), Pittsburgh, Pa.
Composition of low-temperature tar: stability of symmetrical xylenol.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
The utilization of manufactured gas for economically and safely heating and humidifying the home under controlled conditions.

Celluloid Corporation, 290 Ferry Street, Newark, N. J.
Purification of cresylic acid for the manufacture of trycresyl phosphate (camphor substitute).

Coleman and Bell Co., Norwood, Ohio.
Conversion of coal-tar products into various dyestuffs.

Consolidated Gas Co. of New York, 4 Irving Place, New York, N. Y.
Utilization of manufactured gas for cutting and welding.

Consolidated Gas Co. of New York (in cooperation with the American Gas Association, the Dallas Gas Co., the Peoples Gas Light & Coke Co., and the Silica Gel Corporation), 4 Irving Place, New York, N. Y.
Development of gas-operated house-cooling and air-conditioning equipment.

Continental Industrial Engineers (Inc.), 201 North Wells Street, Chicago, Ill.
Processing of coal by-products.

Dallas Gas Co. (in cooperation with the American Gas Association, the Consolidated Gas Co. of New York, the Peoples Gas Light & Coke Co., and the Silica Gel Corporation), Dallas, Tex.
Development of gas-operated house-cooling and air-conditioning equipment.

Darco Corporation, Delaware Trust Building, Wilmington, Del.
Manufacture of active carbon from Texas lignite.

Du Pont Ammonia Corporation, Wilmington, Del.
By-products utilization.

Firestone Tire & Rubber Co., Firestone Park, Akron, Ohio.
Coal-tar products as softeners, antioxidants, or accelerators of vulcanization of rubber.

French Battery Co., 2317 Winnebago Street, Madison, Wis.
Coke utilization in dry-cell manufacture.

The B. F. Goodrich Co., Akron, Ohio.
The utilization of coal products for use in the rubber industry.

Institute of Paint and Varnish Research, 2201 New York Avenue, N.W., Washington, D. C.
Investigation of paint thinners.

State University of Iowa, Department of Chemical Engineering, Iowa City, Iowa.
The catalytic oxidation of hydrogen sulphide in fuel gas.

Jackson Engineering Corporation, 11 East Fifth Avenue, Tulsa, Okla.
Use of triethanolamine in absorption of hydrogen sulphide and carbon dioxide from gases.
Recovery of sulphur or disposal of hydrogen sulphide from foul gases.

Johns Hopkins University, School of Engineering, Department of Gas Engineering, Baltimore, Md.
The origin and decomposition of organic sulphur compounds under gas-making conditions, with special reference to the rôle of the carbon-sulphur complex.
Manufacture of gas with special reference to the purification of the gas and the recovery of synthetic products.

Johns Hopkins University (in cooperation with the American Gas Association), Baltimore, Md.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

Koppers Co. (in cooperation with the Mellon Institute of Industrial Research), Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Coke fellowship.

Lehigh University, Bethlehem, Pa.
The reactivity of various blast furnace and metallurgical cokes to oxygen.

Lehigh University, Department of Chemistry, Bethlehem, Pa.
The absorption of gases in liquids relative to the design and operation of light-oil absorption towers.

Los Angeles Gas and Electric Corporation, Los Angeles, Calif.
Manufacture of gas from oil.

Maltbie Chemical Co., 246 High Street, Newark, N. J.
Study of creosote.

Marquette University, Department of Chemistry, 1217 Wisconsin Avenue, Milwaukee, Wis.
The properties and reactions of triethanolamine and chlorinated napthelenes.

Mattin Laboratories, 220 25th Street, Brooklyn, N. Y.
Chlorination of coal-tar derivatives.

Mellon Institute of Industrial Research (in cooperation with the Koppers Co.), Thackerary Avenue and O'Hara Street, Pittsburgh, Pa.
Coke fellowship.

Metric Metal Works, Erie, Pa.
Gas measurement.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
General problems relating to the manufacture and utilization of manufactured gas.
Dehumidifying city gas.

Mississippi Valley Research Laboratories (Inc.), 660 South 18th Street, St. Louis, Mo.
Gasification of crude oils.

National Carbon Co. (Inc.), Cleveland, Ohio.
Production of carbon electrodes from coke and anthracite.

The Naugatuck Chemical Co., Naugatuck, Conn.
Development of rubber accelerators and antioxidants from coal tar.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Properties of coal and coke in relation to their use as reducing agents in the manufacture of zinc.

Pacific Gas & Electric Co., 4245 Hollis Street, Emeryville, Calif.
The gravity and distillation fractionation of coal-tar creosote which will afford maximum economy with best protection for wooden poles in butt treating by the open-tank method.
Production of gas from California coals.

The Pawtucket Gas Co., Pawtucket, R. I.
Purification and utilization of coal gas.
Deterioration of meters.

Peerless Color Co., 521-535 North Avenue, Plainfield, N. J.
Manufacturing of synthetic dyes, principally of the vat-dye group, using coal-tar intermediates of various kinds.

Peoples Gas Light & Coke Co. (in cooperation with the American Gas Association, the Dallas Gas Co., the Consolidated Gas Co. of New York, and the Silica Gel Corporation), 122 South Michigan Avenue, Chicago, Ill.
Development of gas-operated house-cooling and air-conditioning equipment.

Walter J. Podbielniak, Research Chemical Engineer, 1208 Medical Arts Building, Tulsa, Okla.
Development of precise fractional distillation and other methods for separation of natural and manufactured gas into the individual hydrocarbons (or very close cut fractions) present.

Portland Gas & Coke Co., Public Service Building, Portland, Oreg.
Recovery of by-products from spent oxide-gas purification material.

Purdue University, Engineering Experiment Station (in cooperation with the Indiana Gas Association), Lafayette, Ind.
Comparative heating value of gas, oil, coal, and coke in house heating.

Purdue University, Engineering Experiment Station (in cooperation with the Utilities Research Commission (Inc.)), Lafayette, Ind.
Determination of proper welding procedure for welding with manufactured (city) gas.

The Reilly Chemical Co., 1617 Merchants Bank Building, Indianapolis, Ind.
Processing and utilization of coal-tar products.
Development of flotation reagents.

Robertshaw Thermostat Co., Youngwood, Pa.
Physical characteristics of heating gases.
Physical characteristics of gaseous filled thermostatic bellows.

Rodman Chemical Co., Verona, Pa.
Development of carburizing compounds.
Preparation of activated carbon.

Rutgers University, The College of Agriculture, New Brunswick, N. J.
Use of fertilizers including phosphates, limestones, marls, potash minerals, nitrates, sulphur, ammonium salts, etc.

Silica Gel Corporation (in cooperation with the American Gas Association, the Consolidated Gas Co. of New York, the Dallas Gas Co., and the Peoples Gas Light & Coke Co.), Garratt Building, Baltimore, Md.
Development of gas-operated house-cooling and air-conditioning equipment.

Harold L. Simons (Inc.), 27 44th Road, Long Island City, N. Y.
Coal-tar products as applied to solvents and synthetic pharmaceuticals and aromatic products.

Foster D. Snell, 130 Clinton Street, Brooklyn, N. Y.
Maintaining of proper safety standards of mineral solvents as used in dry cleaning and related industries, before and after treatment for reuse.

Stackpole Carbon Co., Tannery Street, St. Marys, Pa.
Application of carbons and carbon contacts to brake linings.

Standard Oil Co. (Indiana), 910 South Michigan Avenue, Chicago, Ill.
Use of gas as an internal combustion engine fuel.

Standard Oil Development Co., 26 Broadway, New York, N. Y.
Application of fuels to household and industrial heating plants and gas manufacture.

University of Tennessee, Agricultural Experiment Station, Knoxville, Tenn.
Comparison of ammoniates as fertilizers.

Thiokol Corporation, Yardville, N. J.
Manufacture of a rubber-like substance from ethylene and sulphur.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Development of methods for analyzing low-temperature tar.
Development of methods for analyzing light oils.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with Carnegie Institute of Technology), Pittsburgh, Pa.
Composition of low-temperature tar: Stability of symmetrical xylenol.

United States Bureau of Standards, Washington, D. C.
Standards for gas service. The best practice and the requirements made by municipal and state regulatory bodies in the manufacture, distribution, metering, and utilization of fuel gases by public utilities.

United States Bureau of Standards (in cooperation with the American Society of Refrigerating Engineers), Washington, D. C.
Thermal properties of ammonia and other refrigerants.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials, the American Railway Engineering Association, and the American Wood Preservers' Association), Washington, D. C.
Determination of the expansion factor of creosote oil.

United States Geological Survey (in cooperation with the American Petroleum Institute), Washington, D. C.
The determination of the thermal conductivity of gases and its application to the precise analysis of gases.

Agricultural College of Utah, Experiment Station, Logan, Utah.
Use of ammonium sulphate as fertilizer.

Utilities Research Commission (Inc.) (in cooperation with Purdue University), Room 522, 72 West Adams Street, Chicago, Ill.
Determination of proper welding procedure for welding with manufactured (city) gas.

Washington University, St. Louis, Mo.
Study of by-products that may be economically obtained from tar residues resulting from the low-temperature distillation of Illinois coals.

Weiss and Downs (Inc.), 50 East 41st Street, New York, N. Y.
The recovery and processing of light oil, coal tar, and ammonia.
The development of new uses of low-temperature tar and its constituents.
The statistical and competitive position of ammonia and coal tar and the products derived therefrom.

Westinghouse Electric & Manufacturing Co., Research Laboratories, Ardmore Boulevard, East Pittsburgh, Pa.
Production of electrical insulating materials from coal-tar products.

West Virginia University, College of Engineering, Morgantown, W. Va.
Investigation of coal tar from by-product ovens.
Distillation products of West Virginia shales and cannel coals.

The Wilbur White Chemical Co., Owego, N. Y.
Processes for making organic intermediates from coal-tar products.

IX. Complete Gasification, Hydrogenation, and Synthetic Products

American Gas Association, 420 Lexington Avenue, New York, N. Y.
Commercial refrigeration with gas.

American Gas Association, Testing Laboratory, Cleveland, Ohio.
Characteristics of mixed gases.

American Gas Association (in cooperation with Johns Hopkins University), 420 Lexington Avenue, New York, N. Y.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Consolidated Gas Co. of New York, the Dallas Gas Co., the Peoples Gas Light & Coke Co., and the Silica Gel Corporation), 420 Lexington Avenue, New York, N. Y.
Development of gas-operated house-cooling and air-conditioning equipment.

American Petroleum Institute (in cooperation with the United States Geological Survey), 250 Park Avenue, New York, N. Y.
The determination of the thermal conductivity of gases and its application to the precise analysis of gases.

The Brooklyn Union Gas Co., 191 St. James Place, Brooklyn, N. Y.
Cracking problems of gas oil.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
The utilization of manufactured gas for economically and safely heating and humidifying the home under controlled conditions.

The Chemical Service Laboratories (Inc.), 18th and Cherry Streets, Philadelphia, Pa.
Laboratory evaluation of oils used to carburet blue water gas.

Consolidated Gas Co. of New York, 4 Irving Place, New York, N. Y.
Utilization of manufactured gas for cutting and welding.

Consolidated Gas Co. of New York (in cooperation with the American Gas Association, the Dallas Gas Co., the Peoples Gas Light & Coke Co., and the Silica Gel Corporation), 4 Irving Place, New York, N. Y.
Development of gas-operated house-cooling and air-conditioning equipment.

Continental Industrial Engineers (Inc.), 201 North Wells Street, Chicago, Ill.
Preparation of partial oxidation compounds of coal.

Corning Glass Works, Corning, N. Y.
Elimination of water from producer gas and manufacture of producer gas which will burn to minimum flue-gas moisture content.
Metering raw producer gas.

Dallas Gas Co. (in cooperation with the American Gas Association, the Consolidated Gas Co. of New York, the Peoples Gas Light & Coke Co., and the Silica Gel Corporation), Dallas, Tex.
Development of gas-operated house-cooling and air-conditioning equipment.

Du Pont Ammonia Corporation, Wilmington, Del.
Hydrogen production and purification.
Coke water gas production and purification.
Gas compression and catalysation.
Ammonia and alcohol synthesis and utilization, including ammoniation of phosphatic fertilizers.
Studies of general high-pressure synthesis within the field of catalytic gas reactions.

Goodyear Tire & Rubber Co., Akron, Ohio.
Synthesis of useful organic compounds such as butyl chloride, butyl alcohol, and formaldehyde from methane and low-boiling hydrocarbons.

University of Illinois, Engineering Experiment Station, Industrial Chemistry Division, Urbana, Ill.
The hydration of unsaturated hydrocarbons.
The partial oxidation of hydrocarbons (also other organic compounds) in the vapor and liquid phases.

Institute of Paint and Varnish Research, 2201 New York Avenue, N. W., Washington, D. C.
Investigation of paint thinners.

State University of Iowa, Department of Chemical Engineering, Iowa City, Iowa.
The catalytic oxidation of hydrogen sulphide in fuel gas.

Jackson Engineering Corporation, 11 East Fifth Avenue, Tulsa, Okla.
Use of triethanolamine in absorption of hydrogen sulphide and carbon dioxide from gases.
Recovery of sulphur or disposal of hydrogen sulphide from foul gases.

Johns Hopkins University, School of Engineering, Department of Gas Engineering, Baltimore, Md.
Investigation of the manufacture of water gas, with special reference to the decomposition of steam.
The origin and decomposition of organic sulphur compounds under gas-making conditions, with special reference to the rôle of the carbon-sulphur complex.
Manufacture of gas, with special reference to the purification of the gas and the recovery of synthetic products.

Johns Hopkins University (in cooperation with the American Gas Association), Baltimore, Md.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

Kansas State Agricultural College, Engineering Experiment Station, Manhattan, Kans.
Hydrogenation of Kansas coals.

Los Angeles Gas & Electric Corporation, Los Angeles, Calif.
Manufacture of gas from oil.

Louisville Cement Corporation, 315 Guthrie Street, Louisville, Ky.
Study of the hydrogenation of coal and coal products.

Marquette University, Department of Chemistry, 1217 Wisconsin Avenue, Milwaukee, Wis.
The properties and reactions of triethanolamine and chlorinated napthelenes.

Metric Metal Works, Erie, Pa.
Gas measurement.

Michigan Gas Association (in cooperation with the University of Michigan), 47 North Division Avenue, Grand Rapids, Mich.
Utilization of gas oils and other enrichers for making water gas.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
General problems relating to the manufacture and utilization of manufactured gas.
Use of sodium carbonate in gas-producer practice.
Dehumidifying city gas.

University of Michigan, Department of Engineering Research (in cooperation with the Michigan Gas Association), Ann Arbor, Mich.
Utilization of gas oils and other enrichers for making water gas.

Mississippi Valley Research Laboratory (Inc.), 660 South 18th Street, St. Louis, Mo.
Gasification of crude oils.

Pacific Gas & Electric Co., 4245 Hollis Street, Emeryville, Calif.
Production of gas from California coals.

The Pawtucket Gas Co., Pawtucket, R. I.
The utilization of water gas.
Deterioration of meters.
Purification of water gas.
Use of gas oil in the manufacture of water gas.

Peoples Gas Light & Coke Co. (in cooperation with the American Gas Association, the Silica Gel Corporation, the Consolidated Gas Co. of New York, and the Dallas Gas Co.), 122 South Michigan Avenue, Chicago, Ill.
Development of gas-operated house-cooling and air-conditioning equipment.

Pittsburgh Plate Glass Co., Window Glass Research Department, Mt. Vernon, Ohio.
Manufacture of raw producer gas.

Walter J. Podbielniak, Research Chemical Engineer, 1208 Medical Arts Building, Tulsa, Okla.
Development of precise fractional distillation and other methods for separation of natural and manufactured gas into the individual hydrocarbons (or very close cut fractions) present.

Portland Gas & Coke Co., Public Service Building, Portland, Oreg.
Improving durability of fuel briquets made from carbon residue from oil-gas manufacture.
Recovery of by-products from spent oxide gas purification material.

Purdue University, Engineering Experiment Station (in cooperation with the Utilities Research Commission (Inc.)), Lafayette, Ind.
Determination of proper welding procedure for welding with manufactured (city) gas.

Rensselaer Polytechnic Institute, Troy, N. Y.
Equilibrium in the water-gas reaction.

Silica Gel Corporation (in cooperation with the American Gas Association, the Consolidated Gas Co. of New York, the Dallas Gas Co., and the Peoples Gas Light & Coke Co.), Garratt Building, Baltimore, Md.
Development of gas-operated house-cooling and air-conditioning equipment.

Robertshaw Thermostat Co., Youngwood, Pa.
Physical characteristics of heating gases.
Physical characteristics of gaseous filled thermostatic bellows.

Standard Oil Co. (Indiana), 910 South Michigan Avenue, Chicago, Ill.
Use of gas as an internal combustion engine fuel.

Standard Oil Development Co., 26 Broadway, New York, N. Y.
Application of fuels to household and industrial heating plants and gas manufacture.

Sun Oil Co., 1608 Walnut Street, Philadelphia, Pa.
The hydrogenation of various types of coal for the production of hydrocarbon oils.

The United Gas Improvement Co., Physical Laboratory, 3101 Passyunk Avenue, Philadelphia, Pa.
The reformation of hydrocarbons.
Study of gas-oil efficiency.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Hydrocarbon synthesis from water gas: A study of reaction mechanism and new catalysts.

United States Bureau of Standards, Washington, D. C.
Standards for gas service - the best practice, and the requirements made by municipal and state regulatory bodies in the manufacture, distribution, metering, and utilization of fuel gases, by public utilities.

United States Geological Survey (in cooperation with the American Petroleum Institute), Washington, D. C.
The determination of the thermal conductivity of gases and its application to the precise analysis of gases.

Utilities Research Commission (Inc.) (in cooperation with Purdue University), Room 522, 72 West Adams Street, Chicago, Ill.
Determination of proper welding procedure for welding with manufactured (city) gas.

University of Washington, Department of Chemical Engineering, Seattle, Wash.
Hydrogenation of coal.

Yale University, Department of Chemical Engineering, Sterling Chemistry Laboratory, 225 Prospect Street, New Haven, Conn.
Catalytic high-pressure gas reactions of the sort now being applied in the commercial production of ammonia and of methanol and in the manufacture of motor fuel from coal.
Complete gasification of coal.

X. Economics and Miscellaneous

American Gas Association (in cooperation with Johns Hopkins University), 420 Lexington Avenue, New York, N. Y.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Relative costs and application of coal, petroleum, and natural gas as fuels.

Anthracite Institute (in cooperation with Lehigh University), Primos, Delaware County, Pa.
Comparative efficiencies of sand and fine anthracite in water purification.

Anthracite Institute (in cooperation with Pennsylvania State College), 90 West Street, New York, N. Y.
Nonfuel utilization of Pennsylvania anthracite.

University of Arkansas, Fayetteville, Ark.
Comparative costs of coal and natural gas for domestic heating.

Automatic Electric (Inc.), 1023 West Van Buren Street, Chicago, Ill.
Treatment of coal for transmitter purposes.

Burgess Battery Co., Madison, Wis.
The use of natural graphite in dry cells.

French Battery Co., 2317 Winnebago Street, Madison, Wis.
Graphite utilization in dry-cell manufacture.

Johns Hopkins University (in cooperation with the American Gas Association), Baltimore, Md.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

Kansas Engineering Society, Wichita, Kans.
Oil versus gas for domestic heating.

Lehigh University (in cooperation with the Anthracite Institute), Bethlehem, Pa.
Comparative efficiencies of sand and fine anthracite in water purification.

University of Michigan, Gas Engineering Department, Ann Arbor, Mich.
Utilization of bituminous coal in the manufacture of water gas.

Missouri School of Mines and Metallurgy, Department of Mining, Rolla, Mo.
Replacement of other fuels by natural gas.

National Carbon Co. (Inc.), Cleveland, Ohio.
Production of carbon electrodes from coke and anthracite.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Properties of coal and coke in relation to their use as reducing agents in the manufacture of zinc.

University of North Carolina, Chapel Hill, N. C.
Utilization of the "black band" associated with North Carolina coals.

Ohio State University, Engineering Experiment Station (in cooperation with the Bureau of Business Research), Columbus, Ohio.
Study of domestic coal distribution.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Economic survey of mining industry in Pennsylvania.

Pennsylvania State College, School of Mineral Industries (in cooperation with the Anthracite Institute), State College, Pa.
Nonfuel utilization of Pennsylvania anthracite.

Purdue University, Engineering Experiment Station (in cooperation with the Indiana Gas Association), Lafayette, Ind.
Comparative heating value of gas, oil, coal, and coke in house heating.

Speer Carbon Co., St. Marys, Pa.
Use of various types of natural and artificial graphite.

United States Bureau of Mines, Southern Experiment Station, Tuscaloosa, Ala.
Beneficiation of Alabama graphite ores.

United States Geological Survey, Washington, D. C.
Quantity of coal available and the economic features of all deposits.

United States Trust Co. of New York, 45 Wall Street, New York, N. Y.
Effect on coal consumption of greater use of natural gas.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
Comparative costs of oil and coal heating in a residence.

Weiss and Downs (Inc.), 50 East 41st Street, New York, N. Y.
The economics of coal carbonization.
The statistical and competitive position of ammonia and coal tar and the products derived therefrom.

Yale University, Department of Mechanical Engineering, Sheffield Scientific School, Mason Laboratory, 400 Temple St., New Haven, Conn.
Economic studies of the use of pulverized coal in marine steam boilers.

B. PETROLEUM, NATURAL GAS, and ASPHALT

I. Origin, Geology, and Prospecting

American Petroleum Institute (in cooperation with the National Research Council and the University of Illinois), 250 Park Avenue, New York, N. Y.
Limestones and dolomites as reservoir rocks.

American Petroleum Institute (in cooperation with the National Research Council, the Oklahoma Geological Survey, the University of California, and the University of Texas), 250 Park Avenue, New York, N. Y.
The determination of geothermal gradients in oil fields on anticlinal structures.

American Petroleum Institute (in cooperation with the National Research Council and Princeton University), 250 Park Avenue, New York, N. Y.
Origin and environment of source sediments.

American Petroleum Institute (in cooperation with the National Research Council and the United States Geological Survey), 250 Park Avenue, New York, N. Y.
Studies of source rocks in the microfurnace.

American Petroleum Institute (in cooperation with the National Research Council and the University of Wisconsin), 250 Park Avenue, New York, N. Y.
Generation of oil in rocks by shearing pressures.

University of California (in cooperation with the American Petroleum Institute, the National Research Council, the Oklahoma Geological Survey, and the University of Texas), Berkeley, Calif.
The determination of geothermal gradients in oil fields on anticlinal structures.

Carnegie Institute of Technology, Department of Geology, Schenley Park, Pittsburgh, Pa.
Oil and gas sands of the Northern Appalachian region.

Equitable Gas Co., 435 Sixth Avenue, Pittsburgh, Pa.
General problems relating to the location of wells to tap the producing sands for natural gas or oil.

Gypsy Oil Co. and Gulf Pipe Line Co. of Oklahoma, Box 2044, Tulsa, Okla.
Methods and equipment used in searching for petroleum and natural gas.

The Helium Co., Shelby Street and Goss Avenue, Louisville, Ky.
Survey of natural gas for occurrence of helium.

Humble Oil and Refining Co., Houston, Tex.
Geophysical exploration for oil and gas deposits by gravimetric and seismic methods.
Identification and correlation of well samples.

University of Illinois (in cooperation with the American Petroleum Institute and the National Research Council), Urbana, Ill.
Limestones and dolomites as reservoir rocks.

State Conservation Department, Division of Geology, Indianapolis, Ind.
Source materials of Indiana petroleum.

Kansas Geological Survey, Lawrence, Kans.
Surface and subsurface stratigraphy of Kansas.
Origin of structures in western Kansas.

University of Kentucky, Department of Physics, Lexington, Ky.
A method for surveying deep boreholes.

Louisiana State University and Agricultural and Mechanical College, School of Geology, Baton Rouge, La.
Micropaleontological study of Gulf Coast sedimentary rocks.
Sedimentational history of Gulf Coast region.

Montana School of Mines, State Bureau of Mines and Geology, Butte, Mont.
Natural-gas resources of Montana.

National Research Council, Division of Geology and Geography (in cooperation with the American Petroleum Institute, the University of California, the Oklahoma Geological Survey, and the University of Texas), Washington, D. C.
The determination of geothermal gradients in oil fields on anticlinal structures.

National Research Council, Division of Geology and Geography (in cooperation with the American Petroleum Institute and the University of Illinois), Washington, D. C.
Limestones and dolomites as reservoir rocks.

National Research Council, Division of Geology and Geography (in cooperation with the American Petroleum Institute and Princeton University), Washington, D. C.
Origin and environment of source sediments.

National Research Council, Division of Geology and Geography (in cooperation with the American Petroleum Institute and the United States Geological Survey), Washington D. C.
Studies of source rocks in the microfurnace.

National Research Council, Division of Geology and Geography (in cooperation with the American Petroleum Institute and the University of Wisconsin), Washington, D. C.
Generation of oil in rocks by shearing pressures.

National Research Council, Division of Geology and Geography (in cooperation with Pennsylvania State College), Washington, D. C.
Petrographic studies of Pennsylvania oil sands.
Paleontology of the cap rocks of the Bradford sand.

The Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Oil-bearing shales of Ohio.

Oklahoma Geological Survey (in cooperation with the American Petroleum Institute, the University of California, the National Research Council, and the University of Texas), Norman, Okla.
The determination of geothermal gradients in oil fields on anticlinal structures.

State of Oklahoma (in cooperation with the United States Bureau of Mines), Oklahoma City, Okla.
Engineering study of the Oklahoma City field.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Continuity of sandstone beds and shale breaks in the Bradford oil sands.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum and Natural Gas Engineering, State College, Pa.
Studies in sedimentation of Pennsylvania oil and gas sands.

Pennsylvania State College, School of Mineral Industries (in cooperation with the National Research Council), State College, Pa.
Petrographic studies of Pennsylvania oil sands.
Palentology of the cap rocks of the Bradford sand.

Princeton University (in cooperation with the American Petroleum Institute and the National Research Council), Princeton, N. J.
Origin and environment of source sediments.

Standard Oil Co. of California, 225 Bush Street, San Francisco, Calif.
Search for oil.

Stanford University, Stanford University, Calif.
The origin of petroleum from diatoms.

South Dakota Geological Survey, University of South Dakota, Vermillion, S.Dak.
Location of structure and stratigraphic studies.

Southwest Gas Utilities Corporation, Box 478, Ada, Okla.
Attempt to further correlate geological data as especially applicable to natural-gas prospecting.

Texas Technological College, Department of Geology, Lubbock, Tex.
Geological problems connected with West Texas development.

University of Texas (in cooperation with the American Petroleum Institute, the University of California, the National Research Council, and the Oklahoma geological Survey), Austin, Tex.
The determination of geothermal gradients in oil fields on anticlinal structures.

The Trees Oil Co., Winfield, Kans.
Geophysical investigation of oil-bearing formations.

United States Bureau of Mines, Petroleum Experiment Station (in cooperation with the State of Oklahoma), Bartlesville, Okla., and Petroleum Field Office, Dallas, Tex.
Engineering study of the Oklahoma City field.

United States Bureau of Mines, Petroleum Field Office, Dallas, Tex.
Engineering study of the Roberts-Settles Pool, Texas.
Engineering study of West Texas fields.
Engineering study of Zwolle field, Louisiana.

United States Geological Survey, Washington, D. C.
Geologic relations, areal distribution, character, origin, quantity available, and to a certain extent the economic features of deposits of petroleum, oil shale, and bituminous rock, natural gas, and asphalt.
Physical and chemical factors in the accumulation and discharge of petroleum, such as proportion of voids, pore size and shape, pore wall nature of petroleum (fluidity, gas content), purging fluids effective and available for weakening adsorption, permeability for water and oil production and control of open bonds.
Correlation of temperature with geologic structure in the oil fields.

United States Geological Survey (in cooperation with the American Petroleum Institute and the National Research Council), Washington, D. C.
Studies of source rocks in the microfurnace.

Vanderbilt University, Department of Geology, Nashville, Tenn.
Oil and gas distribution in Tennessee and Kentucky.
Gas in northern Alabama.

Venezuelan Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa.
Seismic-wave investigations in connection with geophysical prospecting for petroleum.

University of Wisconsin (in cooperation with the American Petroleum Institute and the National Research Council), Madison, Wis.
Generation of oil in rocks by shearing pressures.

II. Properties and Tests: Motor Fuels and Lubricants

American Petroleum Institute (in cooperation with the National Automobile Chamber of Commerce, the Society of Automotive Engineers, and the United States Bureau of Standards), 250 Park Avenue, New York, N. Y.
Gasoline in its relation to automotive engine performance.

American Photoelectric Corporation, 215 Third Avenue, New York, N. Y.
Evaluation of lubricating oils through accelerated aging and accurate spectrophotometric analysis in both ultra-violet and visible spectrum with A. P. C. photo-electric spectrophotometers.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials, the American Standards Association, the Society of Automotive Engineers, various professional and manufacturing associations and industrial, governmental and university laboratories), 29 West 39th Street, New York, N. Y.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers, the American Standards Association, the Society of Automotive Engineers, various professional and manufacturing associations and industrial, governmental and university laboratories), 1315 Spruce Street, Philadelphia, Pa.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

American Standards Association (in cooperation with the American Society of Mechanical Engineers, the American Society for Testing Materials, the Society of Automotive Engineers, various professional and manufacturing associations and industrial, governmental and university laboratories), 29 West 39th Street, New York, N. Y.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

The Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa.
Optimum properties for motor fuel and lubricants.
Standardization of test for detonating tendency of motor fuel.

Atlantic Refining Co. (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), 260 South Broad Street, Philadelphia, Pa.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

Cadillac Motor Car Co., 2860 Clark Avenue, Detroit, Mich.
Methods of testing lubricants for serviceability.

Combustion Utilities Corporation, 60 Wall Street, New York, N. Y.
Gum-forming compounds in gasoline.

The De Laval Separator Co., Poughkeepsie, N. Y.
Apparatus for measurement of tendency of lubricating oils to form sludge and emulsion.
Service characteristics of Diesel engine lubricating oil.

Detroit Edison Co., Detroit, Mich.
Correlation of laboratory and service tests data on turbine oils.

Electric Boat Co. (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), 11 Pine Street, New York, N. Y.
Characteristics of a satisfactory Diesel-engine fuel oil.

Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y.
Antiknock values in motor fuels.

Fairbanks, Morse & Co. (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), 900 South Wabash Street, Chicago, Ill.
Characteristics of a satisfactory Diesel-engine fuel oil.

Hill Diesel Engine Co. (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), Lansing, Mich.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

Humble Oil & Refining Co., Houston, Tex.
The chemical and physical properties of lubricating oil distillates from different crude sources, with a view to the elimination of undesirable constituents and the improvement of engine performance of the motor oils which may be made from such distillates.
The influence of light hydrocarbons, e.g., propane, isobutane and normal butane, on the quality of gasoline with which they may be blended, with especial reference to vapor pressure, gas-locking tendency and distillation characteristics.

Hupp Motor Car Corporation, Detroit, Mich.
Relative merits of lubricating oils made from different types of crude, especially in regard to the formation of acids and sludge.

Ingersoll-Rand Co. (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), 11 Broadway, New York, N. Y.
Characteristics of a satisfactory Diesel engine fuel oil.

Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.
Tests of lubricating oils to determine qualities, or tests which indicate service value.

State University of Iowa (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), Iowa City, Ia.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

Linfield College, McMinnville, Oreg.
The relation of surface tension to lubrication.

Massachusetts Institute of Technology (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), Cambridge, Mass.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
The volatility of motor fuels.

Montana State School of Mines, State Bureau Mines and Geology, Butte, Mont.
Sulphur content of Montana gasoline.

National Automobile Chamber of Commerce (in cooperation with the American Petroleum Institute, the Society of Automotive Engineers and the United States Bureau of Standards), 366 Madison Avenue, New York, N. Y.
Gasoline in its relation to automotive-engine performance.

Natural Gasoline Association of America, 305 Tulsa Building, Tulsa, Okla.
Analysis and fuel-line temperatures of present commercial and synthetic fuels under all conditions of actual flying.
Evaluation of varying compositions of natural gasoline.
A study of volatility and its relation to engine starting, acceleration, power, vapor lock, and performance.

The Ohio Grease Co., Loudonville, Ohio.
Testing oils to determine suitability for use as lubricants.

University of Oklahoma, Norman, Okla.
Antiknock qualities of gasoline.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Tests for determining effect of low temperatures on lubricants in the presence of refrigerants.

Public Service Electric & Gas Co., Newark, N. J.
Accelerated aging tests of turbine lubricating oil.

Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Engineering, Troy, N. Y.
Characteristics of motor fuels.
Characteristics of lubricating oils.

Society of Automotive Engineers (in cooperation with the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Standards Association, various professional and manufacturing associations, and industrial, governmental and university laboratories), 29 West 39th Street, New York, N. Y.
Study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

Society of Automotive Engineers (in cooperation with the American Petroleum Institute, the National Automobile Chamber of Commerce and the United States Bureau of Standards), 29 West 39th Street, New York, N. Y.
Gasoline in its relation to automotive-engine performance.

L. Sonneborn Sons (Inc.), 114 Fifth Avenue, New York, N. Y.
Depression of pour test of lubricants by means of protective colloids.

Special Research Committee on Diesel Fuel Oil Specifications (the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Standards Association, and the Society of Automotive Engineers), 29 West 39th Street, New York, N. Y.
A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

Standard Oil Co. of New Jersey (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), New York, N. Y.
Physical tests of oil used as Diesel-engine fuel.

Standard Oil Co. of New York, General Laboratories, 412 Greenpoint Avenue, Brooklyn, N. Y.
Fluidity and plasticity of lubricants at low temperatures.

The Texas Co. (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), New York, N. Y.
Physical tests of oil used as Diesel-engine fuel.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Oklahoma.
- Periodical surveys of properties of commercial motor fuels.
- Methods for determining sulphur content of commercial motor fuels.
- Periodic surveys of sulphur content of commercial motor fuels.
- Study of gum content of commercial motor fuels.
- Effect of fractionation on the properties of motor fuels.
- Methods for treatment for removal of deleterious substances from motor fuels.

United States Bureau of Standards, Washington, D. C.
- Antiknock values of motor gasolines.
- Survey of methods of measuring antiknock characteristics of fuels.
- Economic volatility of motor fuels.
- Methods of determination of sulphur in volatile fuels.
- The characteristics of commercial oils for internal-combustion engines.
- Methods of determining acidity in lubricating oils.
- Oxidation test for internal combustion engine oils.
- Standardization of hardness of grease.
- Study of the characteristics of gear-transmission lubricants.

United States Bureau of Standards (in cooperation with the Society of Automotive Engineers, the American Petroleum Institute and the National Automobile Chamber of Commerce), Washington, D. C.
- Gasoline in its relation to automotive-engine performance.

United States Bureau of Standards (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), Washington, D. C.
- A study of properties of Diesel fuels and the development of Diesel fuel oil specifications.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
- Evaluation of lubricating oils by work factor method.
- Developing an accelerated test for gum formation in aviation gasoline when stored.
- Development of a method for determining antiknock values of aviation gasolines and the establishment of a standard antiknock requirement for aviation gasolines.

United States Naval Academy, Engineering Experiment Station (in cooperation with the Special Research Committee on Diesel Fuel Oil Specifications), Annapolis, Md.
- Characteristics of a satisfactory Diesel-engine fuel oil.

Vacuum Oil Co., 61 Broadway, New York, N. Y.
- Fundamental research on petroleum hydrocarbons.

State College of Washington, Department of Physics, Pullman, Wash.
The relation between the lubrication quality of typical lubricating oils and their other physical characteristics.

White Eagle Oil Corporation, 1400 Federal Reserve Bank Building, Kansas City, Mo.
Automotive properties of refined oils.

Yale University, New Haven, Conn.
Comparative tests of lubricants for a rotary ammonia compressor.

Yale University, Department of Electrical Engineering, New Haven, Conn.
Dielectric properties of paraffin and other waxes.

III. Properties and Tests: Miscellaneous

American Gas Association Testing Laboratory, Cleveland, Ohio.
Characteristics of mixed gases.

American Petroleum Institute (in cooperation with the California Institute of Technology), 250 Park Avenue, New York, N. Y.
Determination of solubility of hydrocarbon gases in liquid hydrocarbons, the rate of solution, and the change in viscosity resulting from such solution.

American Petroleum Institute (in cooperation with Johns Hopkins University), 250 Park Avenue, New York, N. Y.
The reactions of a number of selected organic sulphur compounds.

American Petroleum Institute (in cooperation with Massachusetts Institute of Technology), 250 Park Avenue, New York, N. Y.
A study of the relative rates of reaction of the olefins.

American Petroleum Institute (in cooperation with the University of Minnesota), 250 Park Avenue, New York, N. Y.
The effect of electrical discharge upon gaseous hydrocarbons.

American Petroleum Institute (in cooperation with the National Research Council, and the United States Bureau of Standards), 250 Park Avenue, New York, N. Y.
The separation, identification, and determination of the chemical constituents of commercial petroleum fractions.

American Petroleum Institute (in cooperation with the University of North Carolina), 250 Park Avenue, New York, N. Y.
The preparation and properties of thiophanes.

American Petroleum Institute (in cooperation with Stanford University), 250 Park Avenue, New York, N. Y.
The heat capacities and free energies of some typical hydrocarbon compounds.

American Petroleum Institute (in cooperation with the University of Texas), 250 Park Avenue, New York, N. Y.
Isolation and investigation of nitrogen compounds present in petroleum.

American Petroleum Institute (in cooperation with the United States Bureau of Standards), 250 Park Avenue, New York, N. Y.
Thermodynamic properties of petroleum hydrocarbons.

American Petroleum Institute (in cooperation with the United States Geological Survey), 250 Park Avenue, New York, N. Y.
The determination of the thermal conductivity of gases and its application to the precise analysis of hydrocarbons and other gases.

The American Society of Mechanical Engineers (in cooperation with the United States Bureau of Standards), 29 West 39th Street, New York, N. Y.
Viscosity of petroleum at high temperature.
The phenomena of oiliness.

American Society for Testing Materials (in cooperation with the United States Bureau of Standards and the Asphalt Shingle and Roofing Institute), 1315 Spruce Street, Philadelphia, Pa.
Standardization of accelerated weathering tests of bituminous roofing materials.

American Society for Testing Materials (in cooperation with the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Power factor and resistivity of insulating oils.

American Society for Testing Materials (in cooperation with six industrial laboratories), 1315 Spruce Street, Philadelphia, Pa.
Refined ductility tests for bituminous roofing materials.

American Society for Testing Materials (in cooperation with industrial laboratories), 1315 Spruce Street, Philadelphia, Pa.
Method of separation of cut-back asphalt.

American Tar Products Co. (in cooperation with the American Society for Testing Materials), Union Trust Building, Pittsburgh, Pa.
Refined ductility tests for bituminous roofing materials.

Anderson Prichard Oil Corporation, Oklahoma City, Okla; Laboratories, Chicago, Ill.
Comparison of methods of measuring the gum-solvent power of naphtha.

Arizona State Highway Department (in cooperation with the Union Oil Co. of California and the California Highway Commission), Phoenix, Ariz.
Asphaltic residue determinations with modified Brown evaporator head.

Asphalt Shingle and Roofing Institute (in cooperation with the American Society for Testing Materials and the United States Bureau of Standards), 2 West 45th Street, New York, N. Y.
Standardization of accelerated weathering tests of bituminous roofing materials.

Atchison, Topeka & Santa Fe Railway Co., Test Department, Crane and Branner Streets, Topeka, Kans.
Specification for suitable fuel oils for locomotive and power plants and tests of same.

The Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa.
Physical data on petroleum fractions.
Solid hydrocarbons in petroleum.

The Barber Asphalt Co., Technical Bureau, Maurer, N. J.
Determination of physical and chemical properties of asphalt.

The Barber Asphalt Co., Technical Bureau (in cooperation with the American Society for Testing Materials), Maurer, N. J.
Refined ductility tests for bituminous roofing materials.

The Barrett Co. (in cooperation with the American Society for Testing Materials), 40 Rector, New York, N. Y.
Refined ductility tests for bituminous roofing materials.

Bird and Son (in cooperation with the American Society for Testing Materials), Mill Street, East Walpole, Mass.
Refined ductility tests for bituminous roofing materials.

California Highway Commission (in cooperation with the Arizona State Highway Department and the Union Oil Co. of California), Sacramento, Calif.
Asphaltic residue determinations with modified Brown evaporator head.

California Highway Commission (in cooperation with the United States Bureau of Public Roads), Sacramento, Calif.
Determination of general suitability of cut-back asphalt for road purposes.

California Institute of Technology (in cooperation with the American Petroleum Institute), Pasadena, Calif.
Determination of solubility of hydrocarbon gases in liquid hydrocarbons, the rate of solution, and the change in viscosity resulting from such solution.

University of California, Department of Mechanical Engineering, Berkeley, Calif.
Thermal conductivity of petroleum products.

University of California, Department of Mining and Metallurgy, Berkeley, Calif.
The viscosities of gas-oil froths.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
Physical and chemical properties including inflammability and toxicity of a number of halogen derivatives of the hydrocarbons, especially dichlorethylene, trichlorethylene, tetrachlorethylene (the last two primarily as vapor solvents), dichloromethane, pentachlorethane, and orthodichlorbenzine.

The Chemical Service Laboratories (Inc.), 18th and Cherry Streets, Philadelphia, Pa.
Laboratory evaluation of oils used to carburet blue water gas.

Colorado School of Mines, Petroleum Engineering Department, Golden, Colo.
Investigation of gums formed in petroleum products.

University of Colorado, Boulder, Colo.
Rate of solution and solubility at various temperatures and pressure of gases in crude oil.

Commonwealth Edison Co., 72 West Adams Street, Chicago, Ill.
Sludging qualities of transformer oils.

Cornell University, Ithaca, N. Y.
Electron bombardment of hydrocarbons.

Detroit Edison Co., 2000 Second Avenue, Detroit, Mich.
Effect of cathode-ray bombardment on cable compounds and hydrocarbon oils.

Dow and Smith (in cooperation with the American Society for Testing Materials), 131 East 23rd Street, New York, N. Y.
Refined ductility tests for bituminous roofing materials.

Flintkote Co. (in cooperation with the American Society for Testing Materials). 31 St. James Avenue, Boston, Mass.
Refined ductility tests for bituminous roofing materials.

Humble Oil & Refining Co., Houston, Tex.
Fundamental study of the reactions involved in the removal of sulphur compounds and other undesirable constituents of crude distillates, with a view to the improvement of product quality.

Humble Oil & Refining Co., Production Research Division of Development Department, Houston, Tex.
Changes in physical properties of oil and gas with age of field.

Jackson Engineering Corporation, 11 East 5th Avenue, Tulsa, Okla.
Effect of high total pressure (400-800 pounds per square inch) upon the solubility of natural-gas constituents in absorption oil.

Johns Hopkins University (in cooperation with the American Petroleum Institute), Baltimore, Md.
The reactions of a number of selected organic sulphur compounds.

LaMotte Chemical Products Co., McCormick Building, Baltimore, Md.
Determining of pH of oil emulsions.

Massachusetts Institute of Technology (in cooperation with the American Petroleum Institute), Cambridge, Mass.
A study of the relative rates of reaction of the olefins.

Massachusetts Institute of Technology, Research Laboratory of Applied Chemistry, Cambridge, Mass.
Equilibrium vapor-liquid compositions for binary hydrocarbon mixtures in the neighborhood of critical temperature.
Heat content of liquid and gaseous hydrocarbons in the neighborhood of their critical temperatures.

Michigan State Highway Laboratory, Ann Arbor, Mich.
Correlation of routine laboratory tests of asphalts with devised physical tests to determine the characteristics of the most suitable materials for waterproofing bridge concrete.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
The vapor-pressure of hydrocarbons.

University of Minnesota, School of Chemistry (in cooperation with the American Petroleum Institute), Minneapolis, Minn.
The chemical effect of electrical discharge upon gaseous hydrocarbons.

Mississippi College, Chemistry Department, Clinton, Miss.
Quantitative determination of type-sulphur compounds present in petroleum and in petroleum distillates.

National Research Council, Division of Geology and Geography (in cooperation with the American Petroleum Institute and the United States Bureau of Standards), Washington, D. C.
The separation, identification, and determination of the chemical constituents of commercial petroleum fractions.

University of North Carolina (in cooperation with the American Petroleum Institute), Chapel Hill, N. C.
The preparation and properties of thiophanes.

Ohio State Highway Department, Testing Laboratory, Engineering Experiment Station, Ohio State University, Columbus, Ohio.
- Determination of whether asphalts from different sources having approximately the same penetration of 25° C. will vary appreciably in consistency at higher temperatures.
- Density of sheet asphalt mixtures.

University of Oklahoma, Norman, Okla.
- Oklahoma asphalts.
- Paraffin wax.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum and Natural Gas Engineering, State College, Pa.
- Physical and chemical properties of crude oils recovered by different methods of operation and of the residual oil left in the sand.
- Effect of physical properties of oil and orifice dimension on spray formation.
- Viscosity of crude oil under varying conditions.

Walter J. Podbielniak, Research Chemical Engineer, 1208 Medical Arts Building, Tulsa, Okla.
- Development of precise fractional distillation and other methods for separation of natural gas, gasolines, and petroleum into the individual hydrocarbons (or very close cut fractions) present.
- Physicochemical theory of complex mixtures with practical applications to chemical engineering in the petroleum industries.

Rice Institute, Department of Physics, Houston, Tex.
- Thermodynamical theory of cracking petroleum.

Robertshaw Thermostat Co., Youngwood, Pa.
- Physical characteristics of heating gases.
- Physical characteristics of gaseous filled thermostatic bellows.

Rutgers University, Department of Physics, New Brunswick, N. J.
- Surface tension of oils at high temperatures.

Sinclair Refining Co., Development Department, East Chicago, Ind.
- Crystalline and amorphous petroleum waxes.

L. Sonneborn Sons (Inc.), 114 Fifth Avenue, New York, N. Y.
- Constitution, properties, and application of sulphonated hydrocarbons.

University of Southern California, Los Angeles, Calif.
- The effect of radioactivity on oils.

Standard Oil Co. (Indiana), 910 South Michigan Avenue, Chicago, Ill.
- Properties of petroleum and its constituents.

Standard Oil Co. of New Jersey and its Subsidiaries, 26 Broadway, New York, N.Y.
Chemistry of petroleum.

Stanford University, Stanford University, Calif.
Free energies and specific heats of petroleum.

Stanford University (in cooperation with the American Petroleum Institute), Stanford University, Calif.
The heat capacities and free energies of some typical hydrocarbon compounds.

Sun Oil Co., 1608 Walnut Street, Philadelphia, Pa.
The determination of the critical temperatures and the critical pressures of petroleum hydrocarbons.
The determination of the cracking temperatures of various hydrocarbons under different pressures.

Syracuse University, Department of Chemical Engineering, Syracuse, N. Y.
Unsaturated compounds in petroleum.
Sulphur in petroleum.

University of Texas (in cooperation with the American Petroleum Institute), Austin, Tex.
Isolation and investigation of nitrogen compounds present in petroleum.

Tide Water Oil Co., East 22nd Street, Bayonne, N. J.
Study of crude-oil characteristics.

Union Oil Co. of California (in cooperation with the Arizona State Highway Department and the California Highway Commission), Los Angeles, Calif.
Asphaltic residue determinations with modified Brown evaporator head.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.
Study of crude petroleum.
Investigation of sulphur compounds in crude oil.
A study of solubility of natural gas in various crude oils.
Investigation of the effect on crude petroleum of air used in re-pressuring oil fields.

United States Bureau of Mines, Petroleum Field Office, Boulder, Colo.
Distribution of nitrogen and sulphur in oil shale.
Study of nitrogen compounds in oil shale and shale oil.

United States Bureau of Mines, Petroleum Field Office, Laramie, Wyo.
- Laboratory study of physical characteristics of paraffins and waxes.
- Study of solubility of paraffin in solvents from crude oil with and without natural gas in solution.
- Chemical study of the pure wax fractions separated from rod wax or paraffin occurring and precipitated in crude oils.
- Study of the physical and chemical properties of the black oils of the Rocky Mountains.
- Thermodecomposition of Rocky Mountain high-sulphur crudes (black oils).

United States Bureau of Public Roads, Washington, D. C.
- Development of suitable laboratory tests for bituminous mixtures.
- Development and standardization of specifications and tests for bituminous materials.

United States Bureau of Public Roads (in cooperation with the California Highway Commission), Washington, D. C.
- Determination of general suitability of cut-back asphalt for road purposes.

United States Bureau of Standards, Washington, D. C.
- Pressure-volume-temperature of crude oil-natural gas mixtures.
- Development of test methods for testing petroleum products.
- Methods for fractionating petroleum into its constituent hydrocarbons.
- Fluidity of oils at low temperatures.
- Thermodynamic properties of petroleum oils.
- Thermal properties of petroleum and petroleum products.

United States Bureau of Standards (in cooperation with the American Petroleum Institute), Washington, D. C.
- Thermodynamic properties of petroleum hydrocarbons.

United States Bureau of Standards (in cooperation with the American Petroleum Institute and the National Research Council), Washington, D. C.
- The separation, identification and determination of the chemical constituents of commercial petroleum fractions.

United States Bureau of Standards (in cooperation with the American Society of Mechanical Engineers), Washington, D. C.
- Viscosity of petroleum at high temperature.
- The phenomena of oiliness.

United States Bureau of Standards (in cooperation with the American Society of Testing Materials), Washington, D. C.
- Power factor and resistivity of insulating oils.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials and the Asphalt Shingle and Roofing Institute), Washington, D. C.
- Standardization of accelerated weathering tests of bituminous roofing materials.

United States Geological Survey (in cooperation with the American Petroleum Institute), Washington, D. C.
The determination of the thermal conductivity of gases and its application to the precise analysis of hydrocarbons and other gases.

Vacuum Oil Co., 61 Broadway, New York, N. Y.
Fundamental research on petroleum hydrocarbons.

Washington State Highway Department, Olympia, Wash.
Stability studies of bituminous mixtures.

Yale University, Department of Electrical Engineering, New Haven, Conn.
Dielectric properties of paraffin and other waxes.

IV. Development and Production

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.
Treatment of oil-well sludges.

American Gas Association, Natural Gas Department (in cooperation with the United States Bureau of Mines), 420 Lexington Avenue, New York, N. Y.
Study of the flow of natural gas through pipe lines.
Study of methods for gaging and controlling natural gas wells.

American Petroleum Institute (in cooperation with California Institute of Technology), 250 Park Avenue, New York, N. Y.
The fundamentals of the retention of oil by sand.
Determination of solubility of hydrocarbon gases in liquid hydrocarbons, the rate of solution, and the change in viscosity resulting from such solution.

American Society of Mechanical Engineers (in cooperation with the University of Oklahoma), 29 West 39th Street, New York, N. Y.
The efficiencies of all equipment used in drilling a rotary-drilled oil well.

Atlantic Oil Producing Co., Magnolia Building, Dallas, Tex.
Conservation of gas to prolong flowing life of oil wells.

The Barber Asphalt Co., Technical Bureau, Maurer, N. J.
Mining of natural asphalts.

California Institute of Technology, Pasadena, Calif.
Dehydration of oil emulsions.

California Institute of Technology (in cooperation with the American Petroleum Institute), Pasadena, Calif.
- Determination of solubility of hydrocarbon gases in liquid hydrocarbons, the rate of solution, and the change in viscosity resulting from such solution.
- The fundamentals of the retention of oil by sand.

University of California, Department of Electrical Engineering, Berkeley, Calif.
- The high-voltage method of dehydration of petroleum.

University of California, Department of Mining and Metallurgy, Berkeley, Calif.
- The viscosities of gas-oil froths.
- The pressure gradient in the oil sands about a high-pressure well.
- A comparative study of methods of determining porosity and permeability of oil sands.
- The physical properties of mud-laden fluids used in rotary drilling.
- Flow of gas-oil mixtures through vertical pipes, with particular reference to the design of tubing installations in, and pressure control of, gas-lift and flowing wells.
- The effects of pressure, temperature, and dilution on the setting properties and strengths of oil-well cements.

Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.
- Methods of recovery of oil by water and air pressure.
- Permeability of oil sands.

University of Colorado, Boulder, Colo.
- Rate of solution and solubility at various temperatures and pressures of gases in crude oil.

Cornell University, Department of Geology, Ithaca, N. Y.
- Flow of oil, gas, and water through sands.

The Deister Concentrator Co., 901 Glasgow Avenue, Fort Wayne, Ind.
- Conditioning of rotary-drilling mud with vibrating screens.

The De Laval Separator Co., Poughkeepsie, N. Y.
- Centrifugal separation of crude oil from water and emulsion.

The Dorr Co. (Inc.), 247 Park Avenue, New York, N. Y.
- Rotary-drill mud.

Falk and Co., Carnegie, Pa.
- Demulsibility or demulsion of emulsions.

Freeport Sulphur Co., Freeport, Tex.
- Treatment of mud-laded fluid for drilling wells.

Ginter Chemical Laboratory, 118 West Cameron Street, Tulsa, Okla.
Nonferrous heavies for rotary muds.

Gulf Production Co., 1907 Gulf Building, Houston, Tex.
Study of drilling technique to increase drilling speed, improve the quality of hole, prevent loss of holes, and eliminate troubles incident to drilling through high pressure gas zones.

Gypsy Oil Co. and Gulf Pipe Line Co. of Oklahoma, Box 2044, Tulsa, Okla.
Methods and equipment used in producing petroleum and natural gas.
The treating of oil-field emulsions.

Humble Oil & Refining Co., Production Research Division of the Development Department, Houston, Tex.
Study of oil sand drainage and effect on well spacing.
Study and development of production methods for maximum conservation of gas energy and most efficient utilization of gas released with oil.
Chemical problems connected with drilling, especially cement and rotary mud.

Humble Oil & Refining Co., Houston, Tex.
Mud-laden fluids for oil-well drilling.
Oil recovery.

University of Kansas, Department of Mining Engineering, Lawrence, Kans.
Relations of oil and gas under high pressures.

University of Kentucky, Department of Mines and Metallurgy, Lexington, Ky.
The low-temperature distillation of oil shale.

La Motte Chemical Products Co., McCormick Building, Baltimore, Md.
Stabilizing oil emulsions.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Petroleum production fellowship.

The National Refining Co., 1404 East 9th Street, Cleveland, Ohio.
Increased recovery of petroleum from oil sands.

National Research Council, Division of Geology and Geography (in cooperation with Pennsylvania State College), B and 21st Streets, Washington, D. C.
Interfacial tensions relations between sand, water, and oil.
Porosity-permeability relations of Pennsylvania oil sands.

State of Oklahoma (in cooperation with the United States Bureau of Mines), Oklahoma City, Okla.
Disposal of oil-field waters.

University of Oklahoma, Norman, Okla.
- Effect of natural gas in recovery of oil.
- Mud fluids used in oil wells.
- Sucker-rod trouble as encountered in oil wells.

University of Oklahoma, Department of Physics, Norman, Okla.
- The flow of a gas-free oil through a spherical-grain sand.
- The flow of a gas-saturated liquid through a capillary tube.
- The nature of the resistance to flow offered by a (cylindrical) gas bubble in a liquid-filled capillary tube.

University of Oklahoma, School of Mechanical Engineering, Norman, Okla.
- Air-gas lift as applied to the flowing of oil wells.

University of Oklahoma, School of Mechanical Engineering (in cooperation with the American Society of Mechanical Engineers), Norman, Okla.
- The efficiencies of all equipment used in drilling a rotary-drilled oil well.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum, and Natural Gas Engineering, State College, Pa.
- Oil production data for individual properties.
- Study of water in oil sands.
- Oil recovery from sandstone cores.
- Solution viscosity changes in Pennsylvania crude oil when repressured with air or gas.
- Relative oil recovery from cores of different characteristics when repressuring or flooding conditions are the same.
- Does water or sodium carbonate solution remove the oil film from sandstone?
- The plugging effect of sodium carbonate solution and calcium chloride solution in contact in the pores of sandstones.
- Pressure drop in oil sands.
- Effect of water in driving oil out of cores when core drilling.
- The mechanics of fluid flow in oil sands.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum and Natural Gas Engineering (in cooperation with the National Research Council), State College, Pa.
- Interfacial tension relations between sand, water, and oil.
- Porosity-permeability relations of Pennsylvania oil sands.

Petroleum Rectifying Co. of California, 530 West Sixth Street, Los Angeles, Calif.
- Dehydration of petroleum emulsions by electrical process.
- Applicability of electrical fields to removal of suspended and colloidal solids from petroleum.

Pure Oil Co., 35 East Wacker Drive, Chicago, Ill.
Dehydration of crude oil emulsions.

The Reed Roller Bit Co., Box 1863, Houston, Tex.
Investigation of special drilling methods.

St. Bonaventure's College, Department of Chemistry, St. Bonaventure, N. Y.
The determination of desirable properties of water for flooding purposes.

Standard Oil Co. of California, 225 Bush Street, San Francisco, Calif.
Production methods.

Texas Pacific Coal & Oil Co., Thurber, Tex.
Repressuring in Ranger deep production.

The Trees Oil Co., Winfield, Kans.
Analysis of oil field waters, conducted for purpose of top and bottom hole shut-off.

Union Oil Co. of California, 1108 Union Oil Building, Los Angeles, Calif.
Development and improvement of drilling and producing methods looking toward more economical and efficient means of development and recovery.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.
Methods for increasing recovery of oil.
A study of solubility of natural gas in various crude oils.
Investigation of the effect on crude petroleum of air used in repressuring oil fields.
Study of the flow of crude oil through oil sand.
Investigation of pressures and temperatures in deep oil and gas wells.

United States Bureau of Mines, Petroleum Experiment Station (in cooperation with the American Gas Association), Bartlesville, Okla.
Study of the flow of natural gas through pipe lines.
Study of methods for gaging and controlling natural-gas wells.

United States Bureau of Mines, Petroleum Experiment Station (in cooperation with the State of Oklahoma), Bartlesville, Okla.
Disposal of oil-field waters.

United States Bureau of Mines, Petroleum Field Office, Laramie, Wyo.
Thermodynamic study of well efficiencies.

United States Bureau of Mines, Petroleum Field Office, San Francisco, Calif.
Increased oil recovery by repressuring methods.
Temporary shutting in of producing wells to conserve gas and oil underground.

United States Bureau of Standards, Washington, D. C.
Pressure-volume-temperature of crude oil-natural gas mixtures.

United States Geological Survey, Washington, D. C.
Physical and chemical factors in the accumulation and discharge of petroleum, such as proportion of voids, pore size and shape, pore walls, nature of petroleum (fluidity, gas content), purging fluids effective and available for weakening adsorption, permeability for water and oil, production and control of open bonds.
Drilling and production methods of oil and gas.
Nature of oil-field emulsions and means of breaking them down.
Standardization of casing programs in oil and gas fields.
Control and extent of oil and gas drainage.
Repressuring of oil sands by injection of gas or air.
Identification of oil-field waters.

Western Research Corporation, 4300 Galapago Street, Denver, Colo.
Extraction of hydrocarbons from oil sands at Ft. McMurry, Alberta, Canada.

V. Transportation and Storage

American Gas Association (in cooperation with Johns Hopkins University), 420 Lexington Avenue, New York, N. Y.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

American Gas Association, Natural Gas Department (in cooperation with the United States Bureau of Mines), 420 Lexington Avenue, New York, N. Y.
Study of the flow of natural gas through pipe lines.

American Gas Association, Natural Gas Department (in cooperation with the United States Bureau of Mines and the United States Bureau of Standards), 420 Lexington Avenue, New York, N. Y.
Use of certain types of orifice meters in measurement of oil and natural gas.

American Gas Association, Testing Laboratory, Cleveland, Ohio.
Pipe-joint research.

The American Society of Mechanical Engineers, 29 West 39th Street, New York, N.Y
Automatic pipe-line pumping stations.

The Barber Asphalt Co., Technical Bureau, Maurer, N. J.
Transportation of asphalt.

Fuller Company, Catasauqua, Pa.
Transportation and compression of natural and petroleum gases.

Gypsy Oil Co. and Gulf Pipe Line Co. of Oklahoma, Box 2044, Tulsa, Okla.
Losses of light fractions of crude oil in storage and transportation.

Humble Oil & Refining Co., Houston, Tex.
Study of evaporation losses incidental to storage of crude petroleum in the field and during its transportation to the refineries.

Johns Hopkins University (in cooperation with the American Gas Association, Baltimore Md.
Study of scientific and economic considerations entering into the production and distribution of certain proposed gas mixtures.

Lafayette College, Easton, Pa.
The flow of oils and gases.

Los Angeles Gas and Electric Corporation, Box 1100, Station C, Los Angeles, Calif.
Effects of natural gas on old manufactured-gas distribution system.
Rehydration of natural gas with oil and water vapors.

Metric Metal Works, Erie, Pa.
Petroleum and gas measurement.

Missouri Paint and Varnish Co., 5125 North 2nd Street, St. Louis, Mo.
Pipe-line and storage-tank coatings and cements (oil, acid and corrosion resistant).

The National Refining Co., 1404 East 9th Street, Cleveland, Ohio.
Reduction of storage losses and hazards.

University of Oklahoma, Norman, Okla.
The effect of gravity and viscosity change when measuring oil by the orifice meter method.

Rice Institute, Mechanical Engineering Department, Houston, Tex.
Friction loss across welded pipe bends.

Shell Oil Co., 100 Bush Street, San Francisco, Calif.
Transportation of products and by-products from petroleum and natural gas.

Southern California Gas Co., Los Angeles, Calif.
Natural-gas measurement.

Southwest Gas Utilities Corporation, Box 478, Ada, Okla.
Storage of natural gas in old gas fields.

Standard Oil Co. (Indiana), 910 South Michigan Avenue, Chicago, Ill.
Evaporation losses under different storage methods.

Standard Oil Co. (Ohio), Cleveland, Ohio.
Pipe-line versus rail transportation for gasoline for short distances and for small quantities.

Texas Pacific Coal & Oil Co., Thurber, Tex.
Storage of gasoline plant residue gas in depleted gas sands.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.
Study of evaporation losses of petroleum and gasoline.
Study of tank corrosion.

United States Bureau of Mines, Petroleum Experiment Station (in cooperation with the American Gas Association), Bartlesville, Okla.
Study of the flow of natural gas through pipe lines.

United States Bureau of Mines, Petroleum Experiment Station (in cooperation with the American Gas Association and the United States Bureau of Standards), Bartlesville, Okla.
Use of certain types of orifice meters in measurement of oil and natural gas.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla. and Petroleum Field Office, San Francisco, Calif.
Underground storage of gas.

United States Bureau of Mines, Petroleum Field Office, San Francisco, Calif.
Transportation of natural gasoline by pipe line.

United States Bureau of Standards, Washington, D. C.
Standards for gas service: The best practice, and the requirements made by municipal and state regulatory bodies in the manufacture, distribution, metering and utilization of fuel gases by public utilities.

United States Bureau of Standards (in cooperation with the American Gas Association and the United States Bureau of Mines), Washington, D. C.
Use of certain types of orifice meters in measurement of oil and natural gas.

VI. Refining

(Problems on filtering and clarifying earths are listed under C-X.)

American Petroleum Institute (in cooperation with Northwestern University), 250 Park Avenue, New York, N. Y.
Noncatalytic thermal decomposition of pure hydrocarbons and related compounds.

American Petroleum Institute (in cooperation with Princeton University),
250 Park Avenue, New York, N. Y.
Specific adsorbents for sulphur compounds in petroleum.

Arab Gasoline Corporation, Box 997, Eastland, Tex.
Effects of plant conditions on recovery of natural gasoline from natural gas.
Chemical methods of processing natural gas to increase the yield of natural gasoline obtained therefrom.

American Sheet and Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Removal of slight traces of oxygen from natural gas.

The Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa.
Improvement of refining methods.
Removal of sulphur from oils.

The Barber Asphalt Co., Technical Bureau, Maurer, N. J.
Improvements in refining methods of asphaltic oils.
Development of road oils.

Bijur Lubricating Corporation, 22-08 43rd Avenue, Long Island City, N. Y.
Obtaining oil with the proper characteristics for automobile chassis and industrial machinery lubrication.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
Absorptive properties of the hygroscopic fluids such as glycerine, ethylene glycol, diethylene glycol, and triethanolamine.

Centenary College, Shreveport, La.
Removal of sulphur from petroleum fractions.
Thermal decomposition of certain petroleum fractions.

State of Colorado (in cooperation with the United States Bureau of Mines), Denver, Colo.
Refining study and analytical distillation of shale oil.
Refining of shale oil.

Cosma Laboratories Co., 1545 East 18th Street, Cleveland, Ohio.
Elimination of gum-forming constituents in gasoline.

The De Laval Separator Co., Poughkeepsie, N. Y.
- Centrifugal separation of water and sludge from steam turbine lubricating oils.
- Centrifugal purification of Diesel engine lubricating and fuel oils.
- Chemical and centrifugal purification of electrical insulating oils.
- Chemical and centrifugal reclamation of automobile crank-case oils.
- Centrifugal clarification, purification, and processing of dry cleaner's solvent.
- Centrifugal separation of gasoline from treating acid, of lubricating oil from treating acid, and of pepper (acid) from treated petroleum products.
- Centrifugal dewaxing of lubricating oils.
- High-speed test-tube centrifuge for measurement of sediment and water.

The Dorr Co. (Inc), 247 Park Avenue, New York, N. Y.
- Gasoline sweetening.
- Cracking tars and residuums.
- Dewaxing of lubricating oils.
- Treatment of refinery wastes.

Eagle Picher Lead Co., 134 North La Salle Street, Chicago, Ill.
- Production of lead oxides (particularly litharge and red lead) and their application to customers uses, including use in oil refining.

Empire Oil & Refining Co., Box 2067, Tulsa, Okla.
- Refining of motor fuels, lubricants, and various petroleum products.

Ernest Scott & Co., Box 259, Fall River, Mass.
- Distillation and recovery of petroleum and solvent naphtha.

University of Florida, College of Pharmacy, Department of Chemistry, Gainesville, Fla.
- Rectification of waste engine oil.

General Electric Vapor Lamp Co., 410 Eighth Street, Hoboken, N. J.
- The application of ultra-violet in promoting chemical change in refining processes as well as in the production of chemical compounds.

Ginter Chemical Laboratory, 118 West Cameron Street, Tulsa, Okla.
- Light and heavy oil treating.

The Helium Co., Shelby Street and Goss Avenue, Louisville, Ky.
- Improvement in processes for extraction of helium from natural gas.

Humble Oil & Refining Co., Houston, Tex.
- Consideration of the fundamental principles controlling the evaporation of the lighter hydrocarbons from distillates during processing, and also of the methods used in recovering and processing such light hydrocarbons for subsequent utilization as gasoline.
- Study of the factors involved in cracking processes with especial reference to the maximum production of desirable products concurrently with the minimum formation of less valuable by-products.

Hupp Motor Car Corporation, Detroit, Mich.
Relative merits of lubricating oils made from different types of crude, especially in regard to the formation of acids and sludge.

State University of Iowa, Department of Chemical Engineering, Iowa City, Iowa.
The catalytic oxidation of hydrogen sulphide in fuel gas.

Jackson Engineering Corporation, 11 East 5th Avenue, Tulsa, Okla.
Development of calculation methods for predicting light hydrocarbon vapors in absorption, condensation, distillation, and rectification.
Use of triethanolamine in absorption of hydrogen sulphide and carbon dioxide from gases.
Recovery of sulphur or disposal of hydrogen sulphide from foul gases.

Johns Hopkins University, Department of Gas Engineering, School of Engineering, Baltimore, Md.
Purification of gases.

Kansas City Testing Laboratory, 700 Baltimore Avenue, Kansas City, Mo.
Sulphur removal from petroleum and natural gas.

Kendall Refining Co., Bradford, Pa.
Production of antiknock gasoline.
Production of motor oils with low pour-point, lower carbon residue, and demulsibility and greater yields.

Laucks Laboratories (Inc.), 314 Maritime Building, Seattle, Wash.
Refining for domestic use.

Lehigh University, Department of Chemistry, Bethlehem, Pa.
The absorption of gases in liquids relative to the design and operation of light-oil absorption towers.

Lion Oil Refining Co., El Dorado, Ark.
Elimination of sulphur from cracked Smackover gasoline.
Recovery of litharge and caustic from treating plant.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Removal of sulphur from crudes.
Processing of petroleum and natural gas.

Massachusetts Institute of Technology, Research Laboratory of Applied Chemistry, Cambridge, Mass.
Rate of cracking of pure hydrocarbons of low molecular weight.

Massachusetts Institute of Technology, Department of Fuel and Gas Engineering, Cambridge, Mass.
The solvent refining of lubricating oils.
A determination of the rate of cracking of liquid hydrocarbons.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Petroleum-refining fellowship.

Mid-Continent Petroleum Corporation, Tulsa, Okla.
Methods of increasing yields, lowering costs and improving petroleum products.

University of Minnesota, School of Chemistry, Minneapolis, Minn.
The quantitative distribution of sulphur in the products of distillation of an oil shale.

Mississippi College, Chemistry Department, Clinton, Miss.
Removal of mercaptans from petroleum distillates.
Effect of petroleum-refining agents on sulphur compounds present in petroleum distillates.
Removal of hydrogen sulphide from natural gas.

Mississippi Valley Research Laboratory (Inc.), 660 South 18th Street, St. Louis, Mo.
Development of increased lubrication properties of oils.

Monsanto Chemical Works, 1724 South 2nd Street, St. Louis, Mo.
Recovery and utilization of acid sludge.

Montana State School of Mines, State Bureau Mines and Geology, Butte, Mont.
Effect of ultra-violet rays on the distillation of oil shale.

National Electric Heating Co. (Inc.), 154 Nassau Street, New York, N. Y.
Cracking refractory oils by electric treatment and super-high temperature and pressure.

The National Refining Co., 1404 East 9th Street, Cleveland, Ohio.
Increasing recovery of motor fuel from petroleum.
Adapting properties of motor fuel to high-compression motors.

Northwestern University (in cooperation with the American Petroleum Institute) Evanston, Ill.
Noncatalytic thermal decomposition of pure hydrocarbons and related compounds.

The Ohio Grease Company, Loudonville, Ohio.
Treatment and compounding of oils and greases to improve properties for lubricating purposes.

University of Oklahoma, School of Petroleum Engineering, Refining Division, Norman, Okla.
Acid sludge.
Lubricating greases.
Paraffin wax crystallization.
Refining of Oklahoma City crude oil.

Oliver United Filters (Inc.), Federal Reserve Bank Building, San Francisco, Calif.
Contact filtration of petroleum products for brightening and clarification, also for dewaxing.

Pennsylvania State College, State College, Pa.
Methods for the reclamation of oil.

Walter J. Podbielniak, Research Chemical Engineer, 1208 Medical Arts Building, Tulsa, Okla.
Efficient large-scale fractionation of petroleum products.

Portland Gas & Coke Co., Public Service Building, Portland, Oreg.
Recovery of by-products from spent oxide gas purification material.

Princeton University (in cooperation with the American Petroleum Institute), Princeton, N. J.
Specific adsorbents for sulphur compounds in petroleum.

Pure Oil Co., 35 East Wacker Drive, Chicago, Ill.
Development of low-pressure vapor phase cracking process.
Treating vapor phase cracked distillates to make stable motor fuel.

Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Engineering, Troy, N. Y.
Vapor-phase cracking of petroleum intermediates.

Rodman Chemical Co., Verona, Pa.
Processing and compounding for quenching oils.

St. Bonaventure's College, Department of Chemistry, St. Bonaventure, N. Y.
The removal of wax from paraffin distillates.
Effect of doctor treatment on the amount of sulphur and the nature of the sulphur compounds.

Sharples Specialty Co., 23rd and Westmoreland Streets, Philadelphia, Pa.
Separation of acid sludge from lubricating oils.

Shell Oil Co., 100 Bush Street, San Francisco, Calif.
Extraction, transportation, distilling, refining, and identification of products and by-products from petroleum and natural gas.

Simms Oil Co., Magnolia Building, Dallas, Tex.
Reduction of gum and sulphur content of cracked gasoline.
Increase benzol equivalent or antiknock rating of gasoline.
Control of end-point rise due to acid treatment.

Sinclair Refining Co., Development Department, East Chicago, Ind.
The stabilization and recovery of light hydrocarbon compounds contained in commercial gasolines.
Study of gum formation in gasoline and means for prevention of same.

Skelly Oil Co., Tulsa, Okla.
Utilization of animal carbon for vapor-phase treating of sulphurous refinery vapors.

Standard Oil Co. (Indiana), 910 South Michigan Avenue, Chicago, Ill.
Cracking, distillation, and corrosion in petroleum refining.
Production of lubricants.
Specialty products: Wax, candles, polishes, insecticides, medicinal oils.
Asphalt manufacture.
Chemical by-products.

Standard Oil Co. (Ohio), Midland Bank Building, Cleveland, Ohio.
Production of antiknock motor fuel.
Prevention of gum formation in cracked gasoline.
Production of low cold test lubricating oils.

Standard Oil Development Co., 26 Broadway, New York, N. Y.
Manufacture of petroleum products, of medicinal oils, insecticides, and specialty products from petroleum.

Pennsylvania State College, State College, Pa.
Fractional distillation of Pennsylvania straight-run gasoline.
Improvements in knocking qualities of Pennsylvania straight-run gasoline.
Studies of Pennsylvania lubricants.

Struthers-Wells Co., Warren, Pa.
Heat transfer, distillation, and chemical treatment as applied to the design and installation of petroleum-refinery equipment.

Texas Pacific Coal & Oil Co., 1710 Ft. Worth National Bank, Ft. Worth, Tex.
Vapor-phase cracking.

Tide Water Oil Co., East 22nd Street, Bayonne, N. J.
Investigation of new methods of petroleum refining.
Development of improved lubricants, fuels, and other products.
Efficiency tests on plant operating units.

Union Oil Co. of California, Union Oil Building, 617 West 7th Street, Los Angeles, Calif.
- Development of new refining processes.
- Development of new products and improvements in existing products and processes.
- The refining of petroleum.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.
- Separation of wax from lubricating wax distillates.
- Investigation of sulphur compounds in crude oil.
- Study of high-sulphur paraffin-base lubricating oils.

United States Bureau of Mines, Petroleum Field Office, Laramie, Wyo.
- Removing hydrogen sulphide from natural gas by means of a solution of lime and salt.

United States Bureau of Mines, Petroleum Field Office, San Francisco, Calif.
- Removal of asphalt and sulphur compounds from California lubricating crudes by fractional distillation

United States Bureau of Mines, Petroleum Field Office (in cooperation with the State of Colorado), Boulder, Colo.
- Refining study and analytical distillation of shale oil.
- Refining of shale oil.

United States Bureau of Standards, Washington, D. C.
- Reclamation of used automotive lubricating oils.

Universal Oil Products Co., Strauss Building, Chicago, Ill.
- Cracking of oils and gases.

Vacuum Oil Co., 61 Broadway, New York, N. Y.
- Distillation studies.
- Motor-fuel improvement.
- Insulating oil improvement.
- Lubricating oil improvement.
- By-product utilization.

R. B. Vanderbilt Co. (Inc.), 230 Park Avenue, New York, N. Y.; Laboratory, 33 Winfield Street, East Norwalk, Conn.
- Use of antioxidants in gasoline.

Wallace and Tiernan Co., Newark, N. J.
- Removal of sulphur and its compounds.

Weiss and Downs (Inc.), 50 East 41st Street, New York, N. Y.
- The cracking of petroleum hydrocarbons.

West Virginia State College, Institute, W. Va.
Utilization of sludges.

White Eagle Oil Corporation, 1400 Federal Reserve Bank Building, Kansas City, Mo.
Corrosion and erosion in refining equipment.
Methods in treating light-oil products.
Yield analyses of operating equipment.

VII. Special Chemical Processing

Alox Chemical Corporation, Buffalo Avenue and Iroquois Street, Niagara Falls, N. Y.
Conversion of by-products of petroleum refining into useful materials, such as intermediate oil (36-40 distillate) to useful fatty acids for many purposes.
Conversion of solid product of the dewaxing processes into useful products, such as soaps, fatty acids, cutting oil, and special oils.

American Petroleum Institute (in cooperation with Princeton University), 250 Park Avenue, New York, N. Y.
Catalytic methods applied to petroleum hydrocarbons.

Arab Gasoline Corporation, Box 997, Eastland, Tex.
The production of formaldehyde, methanol, and other oxygenated compounds from natural gas.
Chemical methods of processing natural gas to increase the yield of natural gasoline obtained therefrom.

Binney & Smith Co., 41 East 42nd Street, New York, N. Y.
Cracking of natural gas.

Boston College, Chestnut Hill, Mass.
Hydrobromination of propylene.

Carnegie Institute of Technology, Department of Chemical Engineering, Schenley Park, Pittsburgh, Pa.
Commercial products from the catalytic oxidation of petroleum hydrocarbons

Colorado School of Mines, Department of Petroleum Engineering, Golden, Colo.
Investigation of heavy fractions produced by pyrolysis.

Columbia University, Department of Chemical Engineering, New York, N. Y.
Hydrogenation of petroleum by use of hydrogen under high pressure.

Continental Industrial Engineers (Inc.), 201 North Wells Streets, Chicago, Ill.
Preparation of partial oxidation compounds of petroleum.

University of Denver, University Park, Denver, Colo.
Catalytic oxidation of natural gas.

Du Pont Ammonia Corporation, Wilmington, Del.
Gas compression and catalyzation.
Studies of general high-pressure synthesis within the field of catalytic gas reactions.

General Electric Vapor Lamp Co., 410 Eighth Street, Hoboken, N. J.
The application of ultra-violet in promoting chemical change in refining processes, as well as in the production of chemical compounds.

Goodyear Tire and Rubber Co., Akron, Ohio.
Oxidation of petroleum hydrocarbons.
Synthesis of useful organic compounds such as butyl chloride, butyl alcohol, and formaldehyde from methane and low-boiling hydrocarbons.

Great Western Electro-Chemical Co., 9 Main Street, San Franciso, Calif.; Plant, Pittsburg, Calif.
Utilization of natural gas for the manufacture of hydrogen, for the manufacture of carbon tetrachloride and for the manufacture of carbon bisulphide.

Hope and affiliated Natural Gas Companies, 545 Wm. Penn Way, Pittsburgh, Pa.
Extracting, processing, and utilizing various hydrocarbons contained in natural gas.

Hydro Engineering and Chemical Co., Corner Newark and North Avenues, Elizabeth, N. J.
Hydrogenation.

University of Illinois, Engineering Experiment Station, Industrial Chemistry Division, Urbana, Ill.
The hydration of unsaturated hydrocarbons.
The partial oxidation of hydrocarbons and other organic compounds in the vapor and liquid phases.

Johns Hopkins University, Department of Gas Engineering, School of Engineering, Baltimore, Md.
The synthesis of organic products from gases.

E. C. Klipstein & Sons Co., Drawer E, South Charleston, W. Va.
The chlorination of petroleum products.

Lehigh University, Department of Chemistry, Bethlehem, Pa.
Pyrolysis of Louisiana natural gas.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Preparation of various products, such as antiknock gas, chemicals, solvents, and alcohols from petroleum.

Massachusetts Institute of Technology, Research Laboratory of Applied Chemistry, Cambridge, Mass.
Mechanism of hydrocarbon cracking reactions involving change in molecular structure such as formation of aromatics from aliphatics.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Modification of petroleum products.

Monsanto Chemical Works, 1724 South 2nd Street, St. Louis, Mo.
Conversion of methane to acetylene.

The National Refining Co., 1404 East 9th Street, Cleveland, Ohio.
Preparation of organic chemicals from petroleum.

University of Oklahoma, School of Petroleum Engineering, Refining Division, Norman, Okla.
Polymerization of hydrocarbons.
Oxidation of petroleum.

Pittsburgh Testing Laboratory, Pittsburgh, Pa., New York, N. Y., and elsewhere.
Making gasoline noninflammable.

Walter J. Podbielniak, Research Chemical Engineer, 1208 Medical Arts Building, Tulsa, Okla.
Pyrolysis of natural gas on a commercial scale.

Princeton University, Princeton, N. J.
Oxidation, pyrolysis, and chlorination of hydrocarbons.
Catalytic reactions of sulphur compounds in naphtha.

Princeton University (in cooperation with the American Petroleum Institute), Princeton, N. J.
Catalytic methods applied to petroleum hydrocarbons.

Pure Oil Co., 35 East Wacker Drive, Chicago, Ill.
Development of process for converting refinery fixed gases into liquid motor fuel.

The Rice Institute, Department of Chemical Engineering, Houston, Tex.
Industrial products using natural gas as raw material.

Shell Development Co., 100 Bush Street, San Francisco, Calif.; Research Laboratories, Emeryville, Calif.
The better utilization of petroleum by-products and natural gas, particularly in new chemical products.

Skelly Oil Co., Tulsa, Okla.
Utilization of propane and butane for manufacture of benzol and other aromatics.
Utilization of waste residuum (sp. gr. 1.2) from cracking units.

Standard Oil Co. of New Jersey and its Subsidiaries, 26 Broadway, New York, N. Y.
Manufacture of alcohols from refinery gases.

Standard Oil Co. of New York, General Laboratories, 412 Greenpoint Avenue, Brooklyn, N. Y.
Reformation, oxidation and catalysis of hydrocarbons.

Standard Oil Co. (Ohio), Midland Bank Building, Cleveland, Ohio.
Conversion or utilization of low value by-products such as gas and heavy residuums.

Standard Oil Development Co., 26 Broadway, New York, N. Y.
Manufacture of alcohols and other chemicals from petroleum gases.

Sun Oil Co., 1608 Walnut Street, Philadelphia, Pa.
The oxidation of petroleum hydrocarbons for the production of organic acids.
The polymerizations of olefines and their reaction with other hydrocarbons.

The United Gas Improvement Co., Physical Laboratory, 3101 Passyunk Avenue, Philadelphia, Pa.
The reformation of hydrocarbons.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Hydrolysis of natural gas.
Influence of temperature, surface, and homogeneous catalysts on yield of acetylene and ethylene from natural gas.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.
Synthesis of hydrocarbon motor fuels.

United States Bureau of Standards, Washington, D. C.
Effect of constitution on the oxidation of hydrocarbons.

Vacuum Oil Co., 61 Broadway, New York, N. Y.
Pyrolysis and polymerization studies.

Weiss and Downs (Inc.), 50 East 41st Street, New York, N. Y.
Synthetic chemicals from petroleum and natural gas.

Wesleyan University, Department of Chemistry, Middletown, Conn.
The catalytic oxidation of petroleum with cheap material.
The pyrolysis of hydrocarbons in the presence of carbon monoxide.

Yale University, Department of Chemical Engineering, Sterling Chemistry Laboratory, 225 Prospect Street, New Haven, Conn.
Catalytic high-pressure gas reactions of the sort now being applied in the commercial production of ammonia and of methanol and in the manufacture of motor fuel from coal.

VIII. Utilization: Motor Fuels and Lubricants

Alox Chemical Corporation, Buffalo Avenue and Iroquois Street, Niagara Falls, N. Y.
Bodies adsorbed upon metals for increasing oiliness of petroleum lubricating oils, including cutting oils, heavy bearing oils, broaching oils, steam-cylinder oils, cup greases, roll-neck greases, lead-soap greases and oils.

American Petroleum Institute (in cooperation with the National Automobile Chamber of Commerce, the Society of Automotive Engineers, and the United States Bureau of Standards), 250 Park Avenue, New York, N. Y.
Gasoline in its relation to automotive engine performance.

University of Arkansas, Engineering Experiment Station, Fayetteville, Ark.
Positive metering and distribution of gasoline in the internal-combustion engine.

Atchison, Topeka & Santa Fe Railway Co., Test Department, Crane and Branner Streets, Topeka, Kans.
Development of an all-weather railway car oil.

Chas. V. Bacon, 3 Park Row, New York, N. Y.
The use and application of crude and finished petroleum to the industries with especial reference to motor, diesel, domestic and industrial fuel.
Selection of lubricants for specific work.

Bendix Research Corporation, 401 North Bendix Drive, South Bend, Ind.
Use of fuels in internal-combustion engines.

Cadillac Motor Car Co., Detroit, Mich.
Development of steering-gear lubricant with flat viscosity slope, good cold properties, and heavy body when hot.

California Agricultural Experiment Station, College of Agriculture, Davis, Calif.
A study of bearing wear as affected by the character and condition of the lubricant, especially crankcase oil filters and their effect on engine wear.
Air cleaners for the carburetors of internal-combustion engines.

Cooper-Bessemer Corporation, Mt. Vernon, Ohio.
Effect of fuel composition on combustion in the Diesel engine.

General Motors Corporation, Research Laboratories, Detroit, Mich.
The improvement of methods of utilizing gasoline in the automobile engine and on means of making gasoline knock-free.
Means of utilizing petroleum oils in constant-volume or injection-type engines.
Improvement of petroleum oil lubricants.

University of Illinois, Agricultural Experiment Station, Urbana, Ill.
Gas-engine, crank-case lubricating oil studies.

University of Illinois, Engineering Experiment Station and Department of Mechanical Engineering, Urbana, Ill.
Radiometric study of explosions in a gasoline engine.

International Harvester Co., 606 South Michigan Avenue, Chicago, Ill.
Utilization of lubricants and liquid fuels in agricultural machinery.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Preparation of antiknock gas from petroleum.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Investigations of the relation of motor-fuel characteristics to engine performance.

Moraine Products Co., 329 East First Street, Dayton, Ohio.
Plain and porous metal bearing lubrication.

National Automobile Chamber of Commerce (in cooperation with the American Petroleum Institute, the Society of Automotive Engineers and the United States Bureau of Standards), 366 Madison Avenue, New York, N. Y.
Gasoline in its relation to automotive-engine performance.

Neville Chemical Co., Pittsburgh, Pa.
The effect of benzol on the performance of motor gasoline.

New York Edison Co., 4 Irving Place, New York, N. Y.
The sludging of turbine oils.

University of Oklahoma, School of Petroleum Engineering, Refining Division, Norman, Okla.
Lubrication.

Pennsylvania State College, State College, Pa.
The value of reclaimed oil for purposes of lubrication.

Society of Automotive Engineers (in cooperation with the American Petroleum Institute, the National Automobile Chamber of Commerce and the United States Bureau of Standards), 29 West 39th Street, New York, N. Y.
Gasoline in its relation to automotive-engine performance.

Spicer Manufacturing Corporation, 4100 Bennett Road, Toledo, Ohio.
Nonfluid lubricants for motor-car chassis and similar applications.

Standard Oil Co. (Indiana), 910 South Michigan Avenue, Chicago, Ill.
Use of gas as an internal-combustion engine fuel.

Standard Oil Co. of New York, General Laboratories, 412 Greenpoint Avenue, Brooklyn, N. Y.
Automotive fuel and lubricants.

Standard Oil Development Co., 26 Broadway, New York, N. Y.
Application of fuels to internal-combustion engines.

Super Diesel Tractor Corporation, Box 23, LaPorte, Ind.
Devices, nozzles and pumps for solid injection of fuel in internal-combustion engines.

United States Bureau of Standards, Washington, D. C.
Dilution of crank-case oils.
Engine tests of lubricants.
Gaseous fuel carburetor.
Lubrication of aircraft engines under starting conditions.
Piston lubrication.
Thin film lubrication.
Lubricants for fine mechanism.
Vapor lock in airplane fuel systems.

United States Bureau of Standards (in cooperation with the Society of Automotive Engineers, the American Petroleum Institute, and the National Automobile Chamber of Commerce), Washington, D. C.
Gasoline in its relation to automotive-engine performance.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
Automobile engine lubricating: Laboratory comparison of various types of oil as used in a good engine under normal load conditions, testing change in oil, wear in engine, and iron in oil.
A review of the present knowledge of the theory of bearing lubrication and tests with a new type of viscometer and a test bearing, with the object of relating oiliness to other simpler physical properties.

Waukesha Motor Co., Waukesha, Wis.
Internal combustion engine fuel utilization.

Western Clock Co., La Salle, Ill.
Fine clock lubricants.

White Eagle Oil Corporation, 1400 Federal Reserve Bank Building, Kansas City, Mo.
Automotive properties of refined oils.

Yale University, Sheffield Scientific School, Department of Mechanical Engineering, Mason Laboratory, 400 Temple Street, New Haven, Conn.
Internal combustion engine performance on block and chassis dynamometer tests, with particular reference to fuel utilization and detonation.
Investigation of explosion characteristics of various gaseous mixtures, rate of flame front propagation and detonation in internal-combustion engines.

IX. Utilization: Carbon Black

Binney & Smith Co., 41 East 42nd Street, New York, N. Y.
Production of carbon black.

R. H. Brownlee Laboratory (Inc.), 223 Fourth Avenue, Pittsburgh, Pa.
Development of new process and apparatus for making carbon black.

Columbian Carbon Co. (in cooperation with the West Virginia University), 40 East 42nd Street, New York, N. Y.
Utilization of natural gas in carbon-black manufacture.

Godfrey L. Cabot (Inc.), 940 Old South Building, Boston, Mass.
The production of carbon blacks from natural gas.
Incorporation of carbon black in rubber and inks.

Firestone Tire & Rubber Co., Firestone Park, Akron, Ohio.
Evaluation of carbon black for rubber compounding.
Dispersion of carbon black in rubber.

French Battery Company, 2317 Winnebago Street, Madison, Wis.
Carbon-black utilization in dry-cell manufacture.

Goodyear Tire & Rubber Co., Akron, Ohio.
Improved methods of producing carbon black.

Chas. Eneu Johnson & Co., 10th and Lombard Streets, Philadelphia, Pa.
Improving manufacturing process for carbon black.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Preparation of various products such as carbon black from petroleum.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Carbon-black fellowship.

Rensselaer Polytechnic Institute, Troy, N. Y.
Oil-in-water emulsions with carbon black as emulsifier.

Simplex Wire & Cable Co., 201 Devonshire Street, Boston, Mass.
Use of carbon black in rubber insulation.

Thermatomic Carbon Co., 108 Ferry Street, Pittsburgh, Pa.
The development of conservation methods for the manufacture of carbon.
The development of wider uses for thermatomic carbons in the rubber, paint, and ink industries.

West Virginia University, Division of Industrial Sciences (in cooperation with the Columbian Carbon Co.), Morgantown, W. Va.
Utilization of natural gas in carbon-black manufacture.

X. Utilization: Furnaces and Combustion

(Problems on boiler water and its treatment are listed under Section C-XIII. Problems on corrosion are listed under Section D-V.)

American Gas Association, Committee on Industrial Gas Research (in cooperation with the American Gas Furnace Co. and Mr. Robert Guthrie), 420 Lexington Avenue, New York, N. Y.
Application of gas heat to brass melting.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the C. M. Kemp Manufacturing Co.), 420 Lexington Avenue, New York, N.Y.
Development of gas immersion heating elements for galvanizing tanks, and zinc-base die casting.

American Gas Association, Committee on Industrial Gas Research (in cooperation with C. M. Kemp Manufacturing Co. and the Consolidated Gas Co. of New York), 420 Lexington Avenue, New York, N. Y.
Development of immersion stereotype melting equipment.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the University of Michigan), 420 Lexington Avenue, New York, N.Y.
The application of heat to core baking.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the National Machine Works), 420 Lexington Avenue, New York, N.Y.
Improvement of oven-furnace design.

American Gas Association, Committee on Industrial Gas Research (in cooperation with Rutgers University), 420 Lexington Avenue, New York, N. Y.
Improving practices and efficiencies in the utilization of natural gas in the firing of ceramic wares.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation), 420 Lexington Avenue, New York, N. Y.
Development of large-sized short-tunnel burners.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation and the University of Michigan), 420 Lexington Avenue, New York, N. Y.
The utilization of gas for forging.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation and the Standard Gas Equipment Corporation), 420 Lexington Avenue, New York, N. Y.
Development of refractory diaphragm burners.

American Gas Association, Testing Laboratory, Cleveland, Ohio.
Ignition velocities of various fuel gases.
Utilization characteristics of butane-air and butane-city gas mixtures.
Burning gas with preheated air.
Development of standard requirements.
The elimination of noises in industrial gas burners.
Effects of external factors upon the efficiency of gas-fired steam and hot-water radiators.
Fundamentals of combustion space requirements in industrial gas furnaces.

American Gas Furnace Co. (in cooperation with the American Gas Association and Mr. Robert Guthrie), Elizabeth, N. J.
Application of gas heat to brass melting.

American Oil Burner Association (Inc.) (in cooperation with the American Society of Heating and Ventilating Engineers and Yale University), 342 Madison Avenue, New York, N. Y.
Study of performance of oil burners in various types of boilers, furnaces and heating systems.
Study of combustion of fuel oil.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Combustion and efficient use of gas in heating furnaces.

American Society of Heating and Ventilating Engineers (in cooperation with the American Oil Burner Association (Inc.), and Yale University), 4800 Forbes Street, Pittsburgh, Pa.
Study of combustion of fuel oil.
Study of performance of oil burners in various types of boilers, furnaces and heating systems.

American Society of Heating and Ventilating Engineers (in cooperation with Carnegie Institute of Technology), 4800 Forbes Street, Pittsburgh, Pa.
Sizes of steam pipes in low-temperature heating systems.

American Society of Mechanical Engineers (in cooperation with the University of Oklahoma), 29 West 39th Street, New York, N. Y.
The efficiencies of boilers used in drilling a rotary-drilled oil well.

Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.
Combustion control of oil and natural-gas burners.

California Agricultural Experiment Station, College of Agriculture, Davis, Calif.
Study of orchard heaters, including weighing smoke per unit volume of gases emitted and correlating with fuel consumption rate.

University of California, Department of Mechanical Engineering, Berkeley, Calif.
Flame propagation of certain designs of natural-gas atmospheric burners.

Carnegie Institute of Technology, College of Industries, Schenley Park, Pittsburgh, Pa.
Performance of unit heaters.
Performance of low pressure steam heating boilers.

Carnegie Institute of Technology (in cooperation with the American Society of Heating and Ventilating Engineers), Schenley Park, Pittsburgh, Pa.
Sizes of steam pipes in low-temperature heating systems.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
The utilization of natural gas for economically and safely heating and humidifying the home under controlled conditions.
The application of fuel oil and natural gas to combustion under special designs of boilers or generators and furnaces for household and other applications.

Columbia University, Department of Mechanical Engineering, New York, N. Y.
Combustion and furnaces with burners, stokers and other appliances for heat release from fuels.
Heat transfer processes and apparatus.

Combustion Utilities Corporation, 60 Wall Street, New York, N. Y.
Utilization of natural gas.

Consolidated Gas Co. of New York, 4 Irving Place, New York, N. Y.
Nonquenching gas-range burner.
Safety controls for gas appliances.

Consolidated Gas Co. of New York, Laboratories (in cooperation with the American Gas Association and the C. M. Kemp Manufacturing Co.), 4 Irving Place, New York, N. Y.
Development of immersion stereotype melting equipment.

Corning Glass Works, Corning, N. Y.
More effective utilization of gas and oil in the manufacture of glass.
Furnace design.

Detroit Edison Co. (in cooperation with the University of Michigan), 2000 Second Avenue, Detroit, Mich.
Spectrographic analysis of gas.

Detroit Edison Co. (in cooperation with the Superheater Co. and Yale University), 2000 Second Avenue, Detroit, Mich.
Radiation, heat absorption, and progress of combustion.

University of Detroit, Department of Mechanical Engineering, Detroit, Mich.
Capacity and efficiency of oil burners.

C. A. Dunham Co., Marshalltown, Iowa.
Improvement in heating systems for buildings.

Mr. Robert Guthrie, Consulting Metallurgist (in cooperation with the American Gas Association and the American Gas Furnace Co.), 122 South Michigan Avenue, Chicago, Ill.
Application of gas heat to brass melting.

Hagan Corporation, 304 Ross Street, Pittsburgh, Pa.
    Combustion control.

Harrop Ceramic Service Co., 310 West Broad Street, Columbus, Ohio.
    Use of natural gas for firing lime.

University of Illinois, Urbana, Ill.
    Removal of sulphur from stack gases.

University of Illinois, Engineering Experiment Station, Urbana, Ill.
    Method of removing harmful and corrosive constituents from the flue gases of a power plant.

University of Illinois (in cooperation with the Utilities Research Commission, Incorporated), Urbana, Ill.
    Stack gases and their purification.

University of Illinois, Engineering Experiment Station, Department of Mechanical Engineering (in cooperation with the National Warm Air Heating Association), Urbana, Ill.
    Performance of warm-air furnaces and furnace heating systems.

International Combustion Engineering Corporation, 200 Madison Avenue, New York, N. Y.
    Combustion of fuels.
    Heat transfer from burning fuel and products of combustion to water-cooled surfaces.

Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.
    Study of the economy of a gas-fired boiler for domestic heating.

Jackson Engineering Corporation, 11 East Fifth Avenue, Tulsa, Okla.
    Use of triethanolamine in absorption of hydrogen sulphide and carbon dioxide from gases.
    Recovery of sulphur or disposal of hydrogen sulphide from foul gases.

Johns Hopkins University, Baltimore, Md.
    A study of chimney performance.

Johns Hopkins University, Department of Mechanical Engineering, Baltimore, Md.
    Study of the economic distribution of heating surface in large boilers, between water walls, boiler surface, economizer surface and air pre-heater surface.

Johns Hopkins University, Department of Mechanical Engineering (in cooperation with the United States Department of Agriculture), Baltimore, Md.
    Performance of oil burners.

Kansas State Agricultural College, Engineering Experiment Station,
Manhattan, Kans.
Use of oil and gas as fuel in house-heating boilers.

C. M. Kemp Manufacturing Co. (in cooperation with the American Gas Association),
Baltimore, Md.
Development of gas immersion heating elements for galvanizing tanks,
and zinc-base die casting.

C. M. Kemp Manufacturing Co. (in cooperation with the American Gas Association
and the Consolidated Gas Co. of New York), Baltimore, Md.
Development of stereotype immersion melting equipment.

Kewanee Boiler Corporation, Kewanee, Ill.
Performance characteristics of heating boilers.

Los Angeles Gas and Electric Corporation, Los Angeles, Calif.
Manufacture of gas from oil.

Massachusetts Institute of Technology, Department of Fuel and Gas Engineering,
Cambridge, Mass.
Heat transmission in furnaces.
Industrial furnace design.

Massachusetts Institute of Technology (in cooperation with the National
Research Council), Cambridge, Mass.
Measurement of total radiation from hot gases.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street,
Pittsburgh, Pa.
Natural-gas fellowship.

University of Michigan, Department of Chemical Engineering, Ann Arbor, Mich.
Development of high-temperature heating by means of high-boiling
organic vapors.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Methods of heating asphalt.

University of Michigan, Department of Engineering Research (in cooperation
with the American Gas Association), Ann Arbor, Mich.
The application of heat to core baking.

The University of Michigan, Department of Engineering Research (in cooperation
with the American Gas Association and the Surface Combustion Corporation),
Ann Arbor, Mich.
The utilization of gas for forging.

University of Michigan (in cooperation with the Detroit Edison Co.),
Ann Arbor, Mich.
Spectrographic analysis of gas.

University of Michigan, Department of Engineering Research (in cooperation with the Utilities Research Commission, Incorporated), Ann Arbor, Mich.
Brass melting by city gas.

Minneapolis-Honeywell Regulator Co., Wabash, Ind.
Temperature control in furnaces.

Mississippi Valley Research Laboratory (Inc.), 660 South 18th Street, St. Louis, Mo.
Gasification of crude oils.
Investigation of the best construction of furnaces and burners for the utilization of natural gas.

National Machine Works (in cooperation with the American Gas Association), 1559 Sheffield Avenue, Chicago, Ill.
Improvement of oven-furnace design.

National Research Council, Committee on Heat Transmission, 2101 B Street, N.W., Washington, D. C.
Measurement of radiation from nonluminous gases and flames.

National Research Council, Committee on Heat Transmission (in cooperation with the Massachusetts Institute of Technology), 2101 B. Street, N.W., Washington, D. C.
Measurement of total radiation from hot gases.

National Warm Air Heating Association (in cooperation with the University of Illinois), 174 East Long Street, Columbus, Ohio.
Performance of warm-air furnaces and furnace heating systems.

New York Edison System, 4 Irving Place, New York, N. Y.
Investigation of possible hydrocarbon stack loss.

Ohio State University, Engineering Experiment Station (in cooperation with the United States Bureau of Mines), Columbus, Ohio.
A study of the burning characteristics of fuels in ceramic kilns.

University of Oklahoma, School of Mechanical Engineering (in cooperation with the American Society of Mechanical Engineers), Norman, Okla.
The efficiencies of boilers used in drilling a rotary-drilled well.

Oregon State Agricultural College, Mechanical Engineering Department,
Corvallis, Oreg.
Study of the burning of fuels in a furnace wherein pressure is maintained at about 7 atmospheres.
Introduction into boilers of make-up steam instead of make-up water.

Pacific Gas & Electric Co., 245 Market Street, San Francisco, Calif.
Industrial commercial applications of natural gas in lieu of other fuels as well as improvements in the employment of natural gas.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum and Natural Gas Engineering, State College, Pa.
Effect of physical properties of oil and orifice dimension on spray formation.

Peoples Gas Light & Coke Co., 122 South Michigan Avenue, Chicago, Ill.
Fundamentals of gaseous combustion.

Pittsburgh Plate Glass Co., Window Glass Research Department, Mt. Vernon, Ohio.
The use of natural gas in the melting and fabricating of window glass.

Polytechnic Institute of Brooklyn, Department of Mechanical Engineering,
Brooklyn, N. Y.
Comparative tests of house-heating boilers using coal, oil, and gas.
Comparative tests of automatic temperature controls.
Study and comparative tests of gas-burner venturis.

Purdue University, Engineering Experiment Station (in cooperation with the Indiana Gas Association), Lafayette, Ind.
Comparative heating value of gas, oil, coal, and coke in house heating.

Research Corporation, Washington, D. C.
Elimination of sulphur fumes from combustion gases.

W. S. Rockwell Co., South Church Street, New York, N. Y.
Better methods of utilizing oil and gas for industrial heating operations in the metal, ceramic, and chemical industries through improved furnace design.

Rutgers University (in cooperation with the American Gas Association),
New Brunswick, N. J.
Improving practices and efficiencies in the utilization of natural gas in the firing of ceramic wares.

Southern Counties Gas Co., 810 South Flower Street, Los Angeles, Calif.
The burning of lime in shaft kilns with natural gas.

Standard Gas Equipment Corporation (in cooperation with the American Gas Association and the Surface Combustion Corporation), 18 East 41st Street, New York, N. Y.
Development of refractory diaphragm burners.

Standard Oil Development Co., 26 Broadway, New York, N. Y.
Application of fuels to household and industrial heating plants and gas manufacture.

Stevens Institute of Technology, Hoboken, N. J.
Study of atmospheric contamination, its sources as relating to fuel combustion, and its effect, both mechanical and chemical.

Stitzer and Waddell, 1540 Nicholas Building, Toledo, Ohio.
Adaptation of gas-burner equipment for use with various fuel gases.

Superheater Co. (in cooperation with the Detroit Edison Co. and Yale University) 17 East 42nd Street, New York, N. Y.
Radiation, heat absorption, and progress of combustion.

Surface Combustion Corporation, 2375 Dorr Street, Toledo, Ohio.
Applications of new methods of combustion to metallurgical operations.

Surface Combustion Corporation (in cooperation with the American Gas Association), 2375 Dorr Street, Toledo, Ohio.
Development of large-sized short-tunnel burners.

Surface Combustion Corporation (in cooperation with the American Gas Association and the University of Michigan), 2375 Dorr Street, Toledo, Ohio.
The utilization of gas for forging.

Surface Combustion Corporation (in cooperation with the American Gas Association and the Standard Gas Equipment Corporation), 2375 Dorr Street, Toledo, Ohio.
Development of refractory diaphragm burners.

The United Gas Improvement Co., Physical Laboratory, 3101 Passyunk Avenue, Philadelphia, Pa.
The reformation of hydrocarbons.
Study of gas-oil efficiency.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with Ohio State University), Pittsburgh, Pa.
A study of the burning characteristics of fuels in ceramic kilns.

United States Bureau of Standards, Washington, D. C.
Standards for gas service: The best practice and the requirements made by municipal and state regulatory bodies in the manufacture, distribution, metering and utilization of fuel gases by public utilities.
Investigation of the safety and efficiency of utilization of gas.

United States Department of Agriculture (in cooperation with the Johns Hopkins University), Washington, D. C.
Performance of oil burners.

Utilities Research Commission (Inc.) (in cooperation with the University of Illinois), 72 West Adams Street, Chicago, Ill.
Stack gases and their purification.

Utilities Research Commission (Inc.) (in cooperation with the University of Michigan), 72 West Adams Street, Chicago, Ill.
Brass melting by city gas.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
Development of an improved hot-water furnace for domestic use.

West Virginia University, Division of Industrial Sciences, Morgantown, W. Va.
A study of the mechanism of the kinetics of the homogeneous oxidation of hydrocarbons.

Williams Oil-O-Matic Heating Corporation, Bloomington, Ill.
Development of devices to handle oils generally and commercially available.

Yale University, New Haven, Conn.
Performance of oil burners on various types of boilers and furnaces.

Yale University, Sheffield Scientific School, Department of Mechanical Engineering, Mason Laboratory, 400 Temple Street, New Haven, Conn.
Investigation of operating characteristics of oil burners and heating boilers.
Test code for oil burners for low pressure heating boilers.
Performance of low pressure heating boilers using various fuels.
Studies of the combustion process in power boiler furnaces.
Economic performance of furnaces, and boilers, radiators, heat cabinets, hot-blast heaters, etc.

Yale University (in cooperation with the American Oil Burner Association (Inc.) and the American Society of Heating and Ventilating Engineers), New Haven, Conn.
Study of performance of oil burners in various types of boilers, furnaces, and heating systems.
Study of combustion of fuel oil.

Yale University (in cooperation with the Detroit Edison Co. and the Superheater Co.), New Haven, Conn.
Radiation, heat absorption, and progress of combustion.

XI. Utilization: Miscellaneous

Alox Chemical Corporation, Buffalo Avenue and Iroquois Street, Niagara Falls, N. Y.
Acids (fatty) for rubber accelerator activation.

American Gas Association, 420 Lexington Avenue, New York, N. Y.
Commercial refrigeration with gas.

American Gas Association (in cooperation with the United States Bureau of Standards and the American Petroleum Institute), 420 Lexington Avenue, New York, N. Y.
Protective coatings for pipe-line protection.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Silica Gel Corporation, the Peoples Gas Light & Coke Co., the Consolidated Gas Co. of New York, and the Dallas Gas Co.), 420 Lexington Avenue, New York, N. Y.
Development of gas-operated house-cooling and air-conditioning equipment.

American Petroleum Institute (in cooperation with the American Gas Association and the United States Bureau of Standards), 250 Park Avenue, New York, N.Y.
Protective coatings for pipe-line protection.

Anderson Prichard Oil Corporation, Oklahoma City, Okla.; Laboratories, Chicago, Ill.
The essential characteristics required by naphthas for utilization as industrial solvents.
Effect of evaporation rates on suitability of naphtha as a solvent.
Effect of degree of refining on suitability of naphtha as a solvent.

The Barber Asphalt Co., Technical Bureau, Maurer, N. J.
Development of new uses for asphalt.

Bird and Son (Inc.), Research Department, East Walpole, Mass.
General problems of manufacture of asphalt roofing.

The Brooklyn Union Gas Co., 191 St. James Place, Brooklyn, N. Y.
Cracking problems of gas oil.

R. H. Brownlee Laboratory (Inc.), 223 Fourth Avenue, Pittsburgh, Pa.
Process and equipment for making hydrogen from oil and natural gas.

California Agricultural Experiment Station, Davis, Calif.
The efficiency of petroleum-oil animal sprays and their effect on the health and production of dairy cows.

California Division of Highways, Sacramento, Calif.
Stability of asphalt mixtures and sands.

California Division of Highways (in cooperation with the United States Bureau of Public Roads), Sacramento, Calif.
Comparison of various types of asphalt emulsions and other bituminous binders proposed for surfacing projects and maintenance patches.
The volume and weight of traffic that may be economically carried by light-oil surfaces, and the effect of soil and climatic conditions on such surfaces.

Certain-teed Products Corporation, York, Pa.
Suitability of various petroleum asphalts for the manufacture of composition or prepared roofings.

Colorado Agricultural Experiment Station, Fort Collins, Colo.
Road oils.
Light asphaltic road surfaces.

Columbia University, Department of Chemical Engineering, New York, N. Y.
Study of the usefulness of shale oil as an agricultural insecticide and as an insecticide for spraying livestock.

Condit Electrical Manufacturing Corporation, 1344 Hyde Park Avenue, Hyde Park, Mass.
Use of petroleum products as insulation and cooling mediums in electrical apparatus, with special reference to the use of mineral oil for insulating and arc quenching medium in circuit breakers and transformers.

Consolidated Gas Co. of New York (in cooperation with the American Gas Association, the Silica Gel Corporation, the Peoples Gas Light & Coke Co., and the Dallas Gas Co.), 4 Irving Place, New York, N. Y.
Development of gas-operated house-cooling and air-conditioning equipment.

Cornell University, College of Engineering, Ithaca, N. Y.
Oils as insulating medium in electric cables.

Dallas Gas Co. (in cooperation with the American Gas Association, the Consolidated Gas Co. of New York, the Peoples Gas Light & Coke Co., and the Silica Gel Corporation), Dallas, Tex.
Development of gas-operated house-cooling and air-conditioning equipment.

Dow and Smith, 131 East 23rd Street, New York, N. Y.
Increase in weathering properties and waterproofing properties of asphalt and heavy petroleum products by the admixture of different minerals and/or mineral powders.
Interfacial surface tension of different minerals for asphalts and heavy petroleum products looking to the improvement of bituminous paving mixtures and road surfaces.

E. I. du Pont de Nemours & Co., Parlin Laboratory, Parlin, N. J.
Utilization of petroleum hydrocarbons as substitutes for benzol and toluol in nitrocellulose lacquers and solutions.

Firestone Tire & Rubber Co., Firestone Park, Akron, Ohio.
Petroleum products as softeners of raw rubber.

The Gabriel Co., 1407 East 40th Street, Cleveland, Ohio.
Mineral oils in connection with hydraulic shock absorbers.
Oils with minimum change in viscosity due to temperature (-10° to 140°).

General Cable Corporation, High Tension Research Laboratories, 26 Washington Street, Perth Amboy, N. J.
Petroleum products for use as cable saturants and other electrical insulating purposes.

The B. F. Goodrich Co., Akron, Ohio.
The utilization of petroleum products in the rubber industry.

Grand Rapids Varnish Corporation, 565 Godfrey Avenue, SW, Grand Rapids, Mich.
Utilization of petroleum distillates in the manufacturing of paints and varnishes.

The James H. Herron Co., 1360 West Third Street, Cleveland, Ohio.
Development of a water-soluble base for cutting oil.

Humble Oil & Refining Co., Houston, Tex.
Utilization of by-products formed as the result of the production of prime products.

University of Idaho, Department of Entomology, Moscow, Idaho.
Petroleum oils used as insecticides.

Institute of Paint and Varnish Research, 2201 New York Avenue, N.W., Washington, D. C.
Investigation of paint thinners.

Iowa State Highway Commission, Ames, Iowa.
Expansion joint materials.

Chas. Eneu Johnson & Co., 10th and Lombard Streets, Philadelphia, Pa.
Producing new materials from gas.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Utilization of asphalts in the manufacture of paper boards and roofing, and in many other ways as a plastic and a binder.
Utilization of petroleum and natural gas.

University of Maryland, Agricultural Experiment Station, College Park, Md.
Mineral oils and oxydized mineral oils as insecticides.

Massachusetts Agricultural College, Experiment Station, Amherst, Mass.
Systematic study of oil sprays.

Minnesota Agricultural Experiment Station, St. Paul, Minn.
The application of chlorpicrin, the chlorpicrin-carbon tetrachloride mixture (Chapman patent), or other modification of chlorpicrin to industrial fumigation.

Minnesota Agricultural Experiment Station, University Farm, St. Paul, Minn.
Developments of insecticides for orchard spraying, potato spraying, scale-insect control and root-maggot control.

Mississippi Valley Research Laboratory (Inc.), 660 South 18th Street, St. Louis, Mo.
Gasification of crude oils.

Montana Agricultural Experiment Station, Entomology Department, Bozeman, Mont.
A study of lubricating oils to discover effective sprays for use in orchards, shade trees, and for any injurious insects where oil sprays will be useful.

Montana Agricultural Experiment Station (in cooperation with the Western Cooperative Oil Spray Conference), Bozeman, Mont.
The determination of the relations of physical and chemical properties of mineral oils to their toxicity to insects and plants.
The determination of the physical factors involved in the preparation of emulsions of oils and the effect of these factors on the toxicity of the emulsions to insects and plants.

National Carbon Co. (Inc.), Cleveland, Ohio.
Carbon electrodes.

Natural Gasoline Association of America (in cooperation with member companies), 305 Tulsa Building, Tulsa, Okla.
Liquified petroleum gases.
New preparations and uses of the lighter hydrocarbons.

Nebraska State Highway Department, Lincoln, Neb.
Low-cost bituminous road investigation.

New Mexico State Highway Department, Santa Fe, N. Mex.
Determination of grading and per cent of oil to use that will give the most satisfactory results obtainable with given aggregates and a given asphaltic-base road oil.

The Ohio Grease Co., Loudonville, Ohio.
Utilization of greases of various properties.

Pacific Gas & Electric Co., San Francisco, Calif.
Design of oil sprays.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum and Natural Gas Engineering, State College, Pa.
Effect of physical properties of oil and orifice dimension on spray formation.

Peoples Gas Light & Coke Co. (in cooperation with the American Gas Association, the Consolidated Gas Co. of New York, the Dallas Gas Co., and the Silica Gel Corporation) 122 South Michigan Avenue, Chicago, Ill.
Development of gas-operated house-cooling and air-conditioning equipment.

Portland Gas & Coke Co., Public Service Building, Portland, Oreg.
Mechanical sacking of fuel briquets made from carbon residue from oil gas manufacture.
Improving durability of fuel briquets made from carbon residue from oil-gas manufacture.

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.
Sludging and break-down of insulating oil used in electric flow meter bodies.

The Ruberoid Co., 95 Madison Avenue, New York, N. Y.
Bituminous materials for use as waterproofing and protective coatings and paints.

Rutgers University, The College of Agriculture, New Brunswick, N. J.
Insecticides and fungicides containing petroleum.

Silica Gel Corporation (in cooperation with the American Gas Association, the Consolidated Gas Co. of New York, the Dallas Gas Co., and the Peoples Gas Light & Coke Co.), Garratt Building, Baltimore, Md.
Development of gas-operated house-cooling and air-conditioning equipment.

Sinclair Refining Co., Development Department, East Chicago, Ind.
Manufacture of molding and varnish resins from by-products of petroleum-treating processes.

Speer Carbon Co., St. Marys, Pa.
Use of various types of petroleum coke and allied materials.

Stackpole Carbon Co., Tannery Street, St. Marys, Pa.
The reduction of metallic oxides by natural gas.

Standard Oil Co. of Indiana, 910 South Michigan Avenue, Chicago, Ill.
Study of oil sprays.
Asphalt utilization.

Standard Oil Co. of New Jersey, New York, N. Y.
Study of various oil sprays.

Standard Oil Co. of New York, General Laboratories, 412 Greenpoint Avenue, Brooklyn, N. Y.
Research on, and development of, protective coatings.

Standard Oil Co. (Ohio), Midland Bank Building, Cleveland, Ohio.
Conversion or utilization of low-value by-products such as gas and heavy residuums.

Texas Pacific Coal & Oil Co., 1710 Ft. Worth National Bank, Ft. Worth, Tex.
Lead-soap greases.

Thermatomic Carbon Co., 108 Ferry Street, Pittsburgh, Pa.
The use of the hydrogen resultant gas from the thermatomic process (85 per cent hydrogen).
Development of wider uses for thermatomic carbons in the rubber, paint and ink industries.

The Twining Laboratories, 2527 Fresno Street, Fresno, Calif.
Oil sprays and emulsions for insecticides.
Uses for heavy oil.

Union Oil Co. of California, Union Oil Building, 617 West 7th Street, Los Angeles, Calif.
Better utilization of by-products of refining.

The United Gas Improvement Co., Physical Laboratory, 3101 Passyunk Avenue, Philadelphia, Pa.
Study of gas-oil efficiency.

United States Bureau of Mines, Rare and Precious Metals Experiment Station (in cooperation with the University of Nevada), Reno, Nev.
Continuous zinc smelting with natural gas.

United States Bureau of Public Roads, Washington, D. C.
Bituminous treatment of sandy-soil roads.
Bituminous treatment of crushed-stone and gravel roads.

United States Bureau of Public Roads (in cooperation with the California Division of Highways), Washington, D. C.
Comparison of various types of asphalt emulsions and other bituminous binders proposed for surfacing projects and maintenance patches.
The volume and weight of traffic that may be economically carried by light-oil surfaces, and the effect of soil and climatic conditions on such surfaces.

United States Bureau of Standards, Washington, D. C.
Cutting fluids.

United States Bureau of Standards (in cooperation with the American Gas Association and the American Petroleum Institute), Washington, D. C.
Protective coatings for pipe-line protection.

State College of Washington, Agricultural Experiment Station, Pullman, Wash.
Factors influencing the selection of oil sprays.

Western Washington Experiment Station, Puyallup, Wash.
Oil-spraying experiments for control of insect pests.

XII. Safety, Health, and Economics

American Gas Association, Testing Laboratory, 1032 East 62nd Street, Cleveland, Ohio.
Development of standard requirements.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Relative costs and applications of coal, petroleum, and natural gas as fuels.

University of Arkansas, Fayetteville, Ark.
Comparative costs of coal and natural gas for domestic heating.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
Physical and chemical properties, including inflammability and toxicity, of a number of halogen derivatives of the hydrocarbons, more especially dichlorethylene, trichlorethylene, tetrachlorethylene (these last two primarily as vapor solvents), dichloromethane, pentachlorethane, and orthodichlorbenzine.

Caterpillar Tractor Co., Peoria, Ill.
Safety and health pertaining to the industrial use of natural gas and butane gas.

Consolidated Gas Co. of New York, 4 Irving Place, New York, N. Y.
Nonquenching gas range burner.
Safety controls for gas appliances.

Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y.
Safe use of tetraethyl lead.

Ginter Chemical Laboratory, 118 West Cameron Street, Tulsa, Okla.
Oil-field pollution problems.

John Simon Guggenheim Memorial Foundation, 551 Fifth Avenue, New York, N. Y.
Developments in the Mexican oil industry.

Humble Oil & Refining Co., Houston, Tex.
The economics involved in the processing of petroleum crude for useful products.

Kansas Engineering Society, Wichita, Kans.
Oil versus gas for domestic heating.

Los Angeles Gas and Electric Corporation, Box 1100, Station C., Los Angeles, Calif.
Odorization of natural gas.

Mid-Continent Oil and Gas Association, 308 Tulsa Building, Tulsa, Okla.
Causes of accidents.
Development of safe practices.

Minnesota Agricultural Experiment Station, University Farm, St. Paul, Minn.
Toxicity of insecticides.

Missouri School of Mines and Metallurgy, Department of Mining, Rolla, Mo.
Replacement of other fuels by natural gas.

Neville Chemical Co., Pittsburgh, Pa.
Toxicity of crude heavy solvent.

The Ohio Locomotive Crane Co., Bucyrus, Ohio.
Cost of operation using natural gas and oil for small rivet heating furnaces in comparison with electric-heated rivets.

State of Oklahoma (in cooperation with the United States Bureau of Mines), Oklahoma City, Okla.
Study of disposal of oil-field waters.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Effect of character of wire screens or gauzes in stopping flame in exploding gas-air mixtures.

University of Pittsburgh, Department of Oil and Gas Production, Pittsburgh, Pa.
The age-size method of constructing composite oil-well production curves.
The loss-ratio method of extrapolating oil well production curves.
Empirical methods of determining optimum spacing of oil wells.
The pound-loss trend method of computing natural-gas reserves.

Polytechnic Institute of Brooklyn, Department of Mechanical Engineering, Brooklyn, N. Y.
Effect of forced exhaust-gas dilution and methods of reducing carbon monoxide in exhaust gases.

Horace C. Porter, Consulting Chemist, 1833 Chestnut Street, Philadelphia, Pa.
Gas explosions.

Purdue University, Engineering Experiment Station (in cooperation with the Indiana Gas Association), Lafayette, Ind.
Comparative heating value of gas, oil, coal, and coke in house heating.

Foster D. Snell, 130 Clinton Street, Brooklyn, N. Y.
Maintaining of proper safety standards of mineral solvents as used in dry cleaning and related industries, before and after treatment for reuse, by commercial methods.

United States Trust Co. of New York, 45 Wall Street, New York, N. Y.
Effect of increased consumption of natural gas on railroad traffic.
Effect on coal consumption of greater use of natural gas.

Standard Oil Co. (Ohio), Cleveland, Ohio.
General refinery safety.
Unproductive refining capacity for industry as a whole.
Unnecessary or uneconomic duplication of marketing facilities.
Economic disposition of heavy fuel oils at inland points.

Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill.
Flame arrest in vents of oil tanks.
Valves in vents of oil tanks, their capacity and dependability.
Fire hazard of petroleum products, including ignition and flash points, explosion pressure, and rate of flame propagation.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.
Safety work in Mid-Continent fields.

United States Bureau of Mines, Petroleum Experiment Station (in cooperation with the State of Oklahoma), Bartlesville, Okla.
Study of disposal of oil-field waters.

United States Bureau of Mines, Petroleum Field Office, San Francisco, Calif.
Safety in refinery design.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Toxicity and physiological action of dichloro-difluoro-methane.
Toxicity and physiological action of dichloro-fluoro-methane.
Health hazards from aniline and dimethyl aniline.

United States Bureau of Standards, Washington, D. C.
Investigation of the safety and efficiency of utilization of gas.

United States Geological Survey, Washington, D. C.
Unitization of oil and gas fields.
Prevention of waste of oil and gas.
Computation of production curves for certain fields and states.
Preparation of mathematical tables for use in computation of production curves.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
Comparative costs of oil and coal heating in a residence.

Weiss and Downs (Inc.), 50 East 41st Street, New York, N. Y.
The economics of petroleum and natural-gas chemical derivatives.

C. NONMETALLIC MINERALS AND PRODUCTS
(other than Coal (A), Petroleum, Natural Gas, and Asphalt (B))

I. Ceramic Raw Materials

AC Spark Plug Co., Flint, Mich.
Fundamental physical and chemical properties of clays and other non-metallic minerals.

Alfred University, New York State School of Clayworking and Ceramics, Alfred, N.Y.
The melting relations of the system potash feldspar - soda feldspar - quartz and the system potash feldspar - soda feldspar - muscovite mica.

American Chemical Products Co., 7 Litchfield Street, Rochester, N. Y.
Developing uses for complex acid and salt compounds of tungsten and molybdenum, such as phosphotungstic acid, sodium phosphotungstate, ammonium and sodium phosphotungstates, silicotungstic acid, sodium silicotungstate, ammonium and other silicotungstates, phosphomolybdic acid and ammonium, sodium and other phosphomolybdates in ceramics.

American Refractories Institute (in cooperation with the Mellon Institute of Industrial Research), 2218 Oliver Building, Pittsburgh, Pa.
The use in the refractories industry of various types of refractory clays, diaspore, magnesite, chromite, zircon, cyanite, and similar materials.

American Window Glass Co., Farmers' Bank Building, Pittsburgh, Pa.
Selection of correct clay for the specific purpose in glass manufacture.

Anaconda Lead Products Co., 151st and McCook Avenues, East Chicago, Ind.
Lead compounds for ceramic uses and glass making.

The Anthracite Institute (in cooperation with Lehigh University), 90 West Street, New York, N. Y.
The ceramic value of clays and shales associated with the Pennsylvania anthracite.

The Anthracite Institute (in cooperation with Pennsylvania State College), 90 West Street, New York, N. Y.
Suitability of waste products and shales associated with anthracite coals for production of ceramic products.

Bucknell University, Lewisburg, Pa.
The mechanical purification of refractory clays.

Champion Porcelain Co., 8525 Butler Avenue, Detroit, Mich.
Utilization of sillimanite, andalusite, cyanite, and dumortierite in ceramic and other products.

Columbia University (in cooperation with the National Research Council and the United States Geological Survey), New York, N. Y.
Chemical, physical and optical analyses of clay minerals.

The Deister Concentrator Co., 901 Glasgow Avenue, Fort Wayne, Ind.
Separation and recovery of mica and kaolin.
Sizing of clay and shale by the use of vibrating screens.

The Dorr Co., 247 Park Avenue, New York, N. Y.
Clay bleaching.
Glass-sand purification.

The Eagle-Picher Lead Co., 134 North La Salle Street, Chicago, Ill.
Production of lead oxides (particularly litharge and red lead) and their use in the ceramic industries.

Edison General Electric Appliance Co. (Inc.), 5600 West Taylor Street, Chicago, Ill.
Electrical resistivity of fused, crushed, pure magnesium oxide at temperatures up to 2000° F.

University of Florida, College of Pharmacy, Department of Chemistry, Gainesville, Fla.
Chemical and physical tests on Florida clays.

Ford Motor Co., Dearborn, Mich.
Production of magnesia from dolomite.
Production of glass sand from lime-bonded sandstone.

General Electric Co., Research Laboratory, Schenectady, N. Y.
Examination of and experimentation with mineral substances for use in ceramic products such as porcelain and vitreous enamels.

University of Illinois, Department of Ceramic Engineering, Urbana, Ill.
Investigation of the properties of feldspars.
Properties of spinels.

Illinois Wesleyan University, Bloomington, Ill.
Origin of sedimentary white clays.

Division of Geology, State Conservation Department, Indianapolis, Ind.
Origin of Indiana underclays and kaolin.

Iowa State College of Agriculture and Mechanic Arts, Iowa Engineering Experiment Station, Ames, Iowa.
Optimum oxidation temperatures for Iowa clays.

Johns-Manville Corporation, Manville, N. J.
The processing of diatomaceous silica and the use of products made therefrom for heat and cold insulations.

Laclede-Christy Clay Products Co., 1711 Ambassador Building, St. Louis, Mo.
Selection and grading of fire clays in advance of mining.
Proper method of storing and reclaiming clays from various portions of a mine to assure uniform mining.

Homer Laughlin China Co., Newell, W. Va.
Properties, mining and preparation of American clays, feldspar and quartz.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Utilization of shales and fire clays for various purposes.

Lehigh University, Department of Geology (in cooperation with the Anthracite Institute), Bethlehem, Pa.
The ceramic value of clays and shales associated with the Pennsylvania anthracite.

Mellon Institute of Industrial Research (in cooperation with the American Refractories Institute), Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
The use in the refractories industry of various types of refractory clays, diaspore, magnesite, chromite, zircon, cyanite, and similar materials.

Metal and Thermit Corporation, 120 Broadway, New York, N. Y.
Utilization of rutile and ilmenite.

Mississippi Valley Research Laboratory, Incorporated, 660 South 18th Street, St. Louis, Mo.
Elimination of iron and free silica from certain feldspar deposits.
Development of uses for unused Missouri clays.
Development of china clays from new sources.

Missouri School of Mines and Metallurgy, Department of Ceramic Engineering, Rolla, Mo.
The shape of clay grains as produced by various types of milling.
Mechanical weathering of clay.
A determination of the commercial value of high-iron and high-alkali diaspore.

Motor City Testing Laboratory (Inc.), 4410 Elmhurst Street, Detroit, Mich.
The use of different shales.

National Research Council, Division of Geology and Geography (in cooperation with the United States Geological Survey and Columbia University), B and 21st Streets, Washington, D. C.
Chemical, physical and optical analyses of clay minerals.

University of Nebraska, Lincoln, Neb.
- Prospecting for glass sand.
- Location of clay of suitable composition in geographic locations accessible to the plants.

North Carolina State College of Agriculture and Engineering, Department of Ceramic Engineering, Raleigh, N. C.
- Determination of the physical characteristics of the Triassic shales and clays of North Carolina.
- Determining the burning range of pre-Cambrian and Brevard shales.
- Substitution of Etowah buff clay for ball clay in ivory bodies.
- Substitution of pyrophillite for clay in white bodies.
- Determination of the physical characteristics of the larger alluvial clay deposits of North Carolina with special reference to the firing temperature at which the best color and properties are produced.

University of North Dakota, Division of Mines and Mining Experiments, University Station, Grand Forks, N. D.
- Hydrogen ion - viscosity studies of North Dakota clay.
- Survey of the clay deposits of North Dakota.
- Tests of North Dakota clay for ceramic ware.

Ohio State University, Ceramic Engineering Department, Columbus, Ohio.
- The properties of a group of commercial feldspars and their behavior in ceramic bodies.
- Fusion study of the feldspar-kaolin-quartz system.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
- Processing and utilizing Lawrence (Ohio) fire clay.
- Ceramic properties of Ohio shales.
- Removal of pebbles from clays.
- Field survey of shale and surface clay resources of Ohio and laboratory tests for physical and chemical characteristics.
- A study of the ball clays used in tableware bodies.

Oklahoma Agricultural and Mechanical College (in cooperation with the Oklahoma Geological Survey), Stillwater, Okla.
- Study of Oklahoma clays, including laboratory tests for the determination of quality.

Oklahoma Geological Survey (in cooperation with Oklahoma Agricultural and Mechanical College), Norman, Okla.
- Study of Oklahoma clays, including occurrence and availability of deposits.

Oliver United Filters (Inc.), Federal Reserve Bank Building, San Francisco, Calif.
- Filtration (for dewatering) of clay.

Pennsylvania State College (in cooperation with the Anthracite Institute), State College, Pa.
    Suitability of waste products and shales associated with anthracite coals for production of ceramic products.

Pennsylvania State College (in cooperation with the Pennsylvania State Geological Survey), State College, Pa.
    Study of Pennsylvania clays.

Pennsylvania State Geological Survey (in cooperation with Pennsylvania State College), Harrisburg, Pa.
    Study of Pennsylvania Clays.

Pittsburgh Plate Glass Co., Window Glass Research Department, Mt. Vernon, Ohio.
    Study to permit control of materials for window glass with respect to purity, grain size, and constancy of composition.

The Porcelain Enamel and Manufacturing Co., Baltimore, Md.
    The production and use of a cheaper grade of boric oxide-bearing minerals.
    The elimination of coloring elements from minerals used for producing white enamels.

Rutgers University, Department of Ceramics, New Brunswick, N. J.
    Utilization of the Triassic and Ordovician shales of New Jersey.
    Utilization of rutile as a ceramic material.
    Beneficiation of the plastic refractory clays of New Jersey.

Sierra Magnesite Co. (Ltd.), Newark, Calif.
    Removal of silica from crude magnesite.
    Production of artificial periclase in fuel-fired furnaces.
    Production of high-purity magnesium oxide from crude magnesite.

University of South Carolina, Department of Geology, Columbia, S.C.
    Prospecting and mining the kaolin deposits of South Carolina.

Stanford University, Stanford University, Calif.
    The beneficiation of glass sands.
    The concentration of andalusite.

Syracuse University, Syracuse, N. Y.
    The albitization of original basic feldspar.

United States Bureau of Mines, Northwest Experiment Station (in cooperation with the University of Washington), Seattle, Wash.
    Dewatering of clay suspensions.
    Kaolins and feldspars of the Pacific Northwest.
    The purification of kaolins by pneumatic methods.

United States Bureau of Standards, Washington, D. C.
Phase equilibrium diagrams of systems composed of refractory oxides.
Preparation of Sagger clays in relation to their use.
Preparation of kaolins in relation to their utilization.
Preparation and beneficiation of fire clays for the production of refractories.
Development and improvement of methods for the chemical analysis of dolomite, limestone, feldspars, fluorspar, glass sand, phosphate rock, bauxite, and chromite.

United States Bureau of Standards (in cooperation with 12 industrial and private laboratories), Washington, D. C.
Analytical standards of chrome, magnesite, and silica materials used in refractories.

United States Geological Survey, Washington, D. C.
Regional studies of clay resources, including distribution, character, geological relationships, origin, and possible utility.
Identification of shales by ceramic methods.

United States Geological Survey (in cooperation with the National Research Council and Columbia University), Washington, D. C.
Chemical, physical and optical analyses of clay minerals.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
Thermal expansion of refractory oxides.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research, Salt Lake City, Utah.
Removal of feldspar from quartz by flotation.

R. T. Vanderbilt Co. (Inc.), 230 Park Avenue, New York, N. Y.; Laboratories at 33 Winfield Street, East Norwalk, Conn.
Use of pyrophyllite in ceramic bodies.

Vitrefrax Corporation, 5050 Pacific Boulevard, Los Angeles, Calif.
Concentration of aluminum silicate minerals.
Stabilization of ceramic minerals.
Removal of specking impurities in ceramic minerals.
Heat treatment of ceramic minerals to alter crystalline form.

Washington and Jefferson College, Department of Chemistry, Washington, Pa.
Colloidal properties, particle size, reactions to reagents, and other properties of certain standard clays.

West Virginia University, Division of Industrial Sciences, Morgantown, W. Va.
Investigations of the properties of West Virginia clays.

II. Heavy Clay Products and Refractories

American Face Brick Association (in cooperation with the United States Bureau of Standards, the National Lime Association, and manufacturers of masonry cements), 205 West Wacker Drive, Chicago, Ill.
- Means of preventing moisture penetration of masonry walls.
- The expansion and contraction of mortars and of bricks caused by change in moisture content and in temperature.

American Gas Association, Committee on Industrial Gas Research (in cooperation with Rutgers University), 420 Lexington Avenue, New York, N. Y.
- Improving practices and efficiencies in the application of gas in the ceramics industry.

American Refractories Institute (in cooperation with the Mellon Institute of Industrial Research), Oliver Building, Pittsburgh, Pa.
- Fellowship on refractories.

American Smelting & Refining Co., 120 Broadway, New York, N. Y.
- Magnesite brick investigations.

American Society of Mechanical Engineers (in cooperation with the Battelle Memorial Institute), 29 West 39th Street, New York, N. Y.
- Laboratory slag tests on various refractories.

American Society of Mechanical Engineers (in cooperation with the University of Illinois), 29 West 39th Street, New York, N. Y.
- Development of slagging test for boiler-furnace refractories.

American Society of Mechanical Engineers (in cooperation with the United States Bureau of Standards), 29 West 39th Street, New York, N. Y.
- Determination of the reactions and equilibria that underlie refractory failures in boiler furnaces.
- Study of crystalline compounds formed in slags on boiler-furnace refractories.
- The effects of reducing atmospheres on slag action on fire brick.

American Society for Testing Materials (in cooperation with Mellon Institute of Industrial Research), 1315 Spruce Street, Philadelphia, Pa.
- Service spalling test of refractories.
- Heat transfer in refractory materials.

American Society for Testing Materials (in cooperation with the Missouri School of Mines and Metallurgy), 1315 Spruce Street, Philadelphia, Pa.
- P. C. E. test for refractories.

American Society for Testing Materials (in cooperation with Pennsylvania State College), 1315 Spruce Street, Philadelphia, Pa.
- Abrasion of refractories at high temperatures.

Atlas Lumnite Cement Co., 135 East 24th Street, New York, N. Y.
Properties of calcium aluminate cement in mortar and concrete for refractory uses.

The Babcock & Wilcox Co., 85 Liberty Street, New York, N. Y.
Development of high-temperature cements and plastics for use in furnaces.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Study of action of a series of coal ash slags on a series of special boiler-furnace refractories.

Battelle Memorial Institute (in cooperation with the American Society of Mechanical Engineers), 505 King Avenue, Columbus, Ohio.
Laboratory slag tests on various refractories.

Clay Products Association (in cooperation with the University of Illinois), 1847 Conway Building, 111 West Washington Street, Chicago, Ill.
Ceramic properties of flue lining, clay sewer pipe, and other materials.
Jointing materials for sewer pipe, flue lining, clay sewer pipe, and similar materials.
Utilization of clay for the manufacture of vitrified-clay sewer pipe.

Common Brick Manufacturers Association (in cooperation with Rensselaer Polytechnic Institute), 2121 Guarantee Building, Cleveland, Ohio.
Study of reinforced-brick work.

Common Brick Manufacturers Association (in cooperation with the United States Bureau of Standards), 2121 Guarantee Building, Cleveland, Ohio.
Compressive, tensile, and transverse strengths of brick and mortar compounds.
Survey of the physical properties of common brick manufactured in the United States.
Moisture transmission of brick walls.
Physical properties and performance of brick-masonry structures.

Corning Glass Works, Corning, N. Y.
Development of refractories for glass containers.

Electro Refractories Corporation, 66 Andrews Building, Buffalo, N. Y.
Development of refractory brick and cements from magnesite, aluminum and plastic clays, for use in ferrous and nonferrous foundries.

Ford Motor Co., Dearborn, Mich.
Production of magnesia from dolomite.
Production of high-alumina refractories.

General Refractories Co., 106 South 16th Street, Philadelphia, Pa.
Production of basic, neutral, and acid refractory materials.

Gladding, McBean & Co., 2901 Los Feliz Boulevard, Los Angeles, Calif.
The development of refractories from aluminum silicate minerals, such as cyanite, andalusite and dumortierite.
The development of refractories from pure kaolin and kaolinite minerals.
The development of unglazed vitrified sewer pipe.
The development and application of a waterproofing compound to prevent scumming and efflorescence of clay wares after use in building.
The effect of synthetic potash minerals on the absorption and elimination of free quartz expansion in clay bodies.

Harbison-Walker Refractories Co., 1800 Farmers Bank Building, Pittsburgh, Pa.
The manufacture of refractories and the use of refractory materials such as fire clay, quartzite, magnesite, chrome, and diaspore.

Harrop Ceramic Service Co., 310 West Broad Street, Columbus, Ohio.
Drying, firing and glazing of ceramic products.

The Hoover Co., North Canton, Ohio.
Effect of ash composition on slagging of furnace refractories.

Robert W. Hunt Co., 166 West Van Buren Street, Chicago, Ill.
Cause of green spots on white facing brick.

University of Illinois, Department of Ceramic Engineering, Urbana, Ill.
Properties of spinels.
Drying of clay wares.
Resistance of some clay bodies to thermal shock.
Studies on oxidation of shale and fire-clay bodies.
Determination of manner in which destruction of fire brick proceeds in the fire box of power plant boilers.

University of Illinois (in cooperation with the American Society of Mechanical Engineers), Urbana, Ill.
Development of slagging test for boiler-furnace refractories.

University of Illinois (in cooperation with the Clay Products Association), Urbana, Ill.
Ceramic properties of flue lining, clay sewer pipe, and other materials.
Utilization of clay for the manufacture of vitrified-clay sewer pipe.
Jointing materials for sewer pipe, flue lining, clay sewer pipe, and similar materials.

Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.
Making high-temperature cements from scrap refractories.

Johns-Manville Corporation, Manville, N. J.
The development and improvement of refractory cements to meet specific conditions.

Laclede-Christy Clay Products Co., 1711 Ambassador Building, St. Louis, Mo.
- Development of body mixtures for vitrified ware (sewer pipe).
- Burning treatment to produce best salt glazes.
- Development of dense, nonshrinking, nonspalling refractories.
- Methods for the control of sizes of refractories.
- Use of mineralizers in high-alumina products.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
- Preparation of roofing granules from shale and fire clays with simultaneous production of brick.
- Preparation of brick of certain desired colors.
- Study of glazes and colors in ceramic roofing tile.

Massachusetts Institute of Technology, Department of Physics, Cambridge, Mass.
- Thermal conductivity of refractories at high temperatures.
- Slag resistance of refractories at high temperatures.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
- Testing and properties of refractories.

Mellon Institute of Industrial Research (in cooperation with the American Refractories Institute), Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
- Fellowship on refractories.

Mellon Institute of Industrial Research (in cooperation with the American Society for Testing Materials), Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
- Service spalling test of refractories.
- Heat transfer in refractory materials.

Missouri School of Mines and Metallurgy, Department of Ceramic Engineering, Rolla, Mo.
- The effect of grog size on the dry-pressing characteristics of fire-clay mixes.
- The heat-resisting qualities of high-temperature cements when subjected to various preheating treatments.
- The manufacture of a super-refractory brick from an all hard flint-clay mix.
- The effect of pressure, moisture, shape of grain and time of pressure application in the manufacture of dry-press fire brick.
- The development of a dense surface refractory brick for use in acid vats, soda furnaces, and the like, using Missouri fire clay.
- The application of colors to stiff-mud fire brick.
- Bonding of anhydrite.
- The volume changes which Missouri fire brick undergoes when subjected to various heat treatments.
- Refractories made of mixtures of chrome and diaspore.
- The effect of grog on pressure transmission in dry pressing.
- The disintegration of green Missouri fire-clay bodies at low temperature.
- The refractory qualities of mixtures of burley, flint, and plastic clays.
- The development of an artificial substitute for firestone.
- Miscellaneous dry-press problems.

Missouri School of Mines and Metallurgy (in cooperation with the American Society for Testing Materials), Rolla, Mo.
P. C. E. test for refractories.

Missouri State Highway Department, Jefferson City, Mo.
The relative service rendered by culverts of corrugated metal pipe, vitrified-clay pipe, concrete pipe, and concrete boxes.

National Lime Association (in cooperation with the American Face Brick Association, the United States Bureau of Standards, and manufacturers of masonry cements), Washington, D. C.
Means of preventing moisture penetration of masonry walls.
The expansion and contraction of mortars and of bricks caused by change in moisture content and in temperature.

University of Nebraska, Lincoln, Neb.
Study of blending of clay.
Study of burning of clay products.

North Caolina State College of Agriculture and Engineering, Department of Ceramic Engineering, Raleigh, N. C.
Survey of structural clay products plants.
Investigation of North Carolina hollow tile.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Dry-pressed refractories.
Study of sewer pipe.
Salt-glazing problems.
Increase of porosity of stiff-mud brick.
Dry-pressing of paving brick.
Ceramic industries investigation.
Dissociation changes developed in various clays during process of firing.
Study of kiln design.
Heat conductivity of refractories.
A study of checker brick in the steel industry.
Structural-clay building tile for floor construction.
Tests of masonry pilasters.
The slag-pressing of refractories.
Engineering data on clay products and their use.

Oklahoma Agricultural and Mechanical College, Stillwater, Okla.
The development of floor and wall tile bodies from Oklahoma clays.

Onondaga Pottery Co., Laboratory, 1858 West Fayette Street, Syracuse, N. Y.
Development of suitable refractories for chinaware manufacture.

Pennsylvania State College, School of Mineral Industries (in cooperation with the American Society for Testing Materials), State College, Pa.
Development of a standard test for resistance of refractories to abrasion at high temperatures.

Polytechnic Institute of Brooklyn, Department of Mechanical Engineering, Brooklyn, N. Y.
Comparative tests on heat transmission in refractories.

Rensselaer Polytechnic Institute, Troy, N. Y.
Refractory materials for cutting tools and dies.

Rensselaer Polytechnic Institute (in cooperation with the Common Brick Manufacturers Association of America), Troy, N. Y.
Study of reinforced-brick work.

Rose Polytechnic Institute, Terre Haute, Ind.
Design of dies for auger machines producing building tiles from center-point clay.
Study of drying and burning processes for center-point clay, including studies of loss of weight and shrinkage throughout the whole process with consequent changes in the time schedules and end points.

Rossman Corporation, Beaver Falls, Pa.
Floor and wall tile bodies and glazes.

Rutgers University (in cooperation with the American Gas Association), New Brunswick, N. J.
Improving practices and efficiencies in the application of gas in the ceramics industry.

Sierra Magnesite Co. (Ltd.), Newark, Calif.
Production of artificial periclase in fuel fired furnaces.
Production of refractories from artificial periclase.
Production of high purity magnesium oxide from crude magnesite.

Solidon Products (Inc.), Wolf and Water Streets, Philadelphia, Pa.
Preparation of magnesia cements.

United States Bureau of Standards, Washington, D. C.
Phase equilibrium diagrams of systems composed of refractory oxides.
Preparation of special refractories and refractory materials.
Properties of architectural terra cotta.
Thermal conductivity of refractories.

United States Bureau of Standards (in cooperation with the American Face Brick Association, the National Lime Association and manufacturers of masonry cement), Washington, D. C.
Means of preventing moisture penetration of masonry walls.
The expansion and contraction of mortars and of bricks caused by change in moisture content and in temperature.

United States Bureau of Standards (in cooperation with the American Society of Mechanical Engineers), Washington, D. C.
- Determination of the reactions and equilibria that underlie refractory failures in boiler furnaces.
- Study of crystalline compounds formed in slags on boiler-furnace refractories.
- The effects of reducing atmospheres on the slag action of fire brick.

United States Bureau of Standards (in cooperation with the Common Brick Manufacturers Association), Washington, D. C.
- Compressive, tensile, and transverse strengths of brick and mortar compounds.
- Survey of the physical properties of common brick manufactured in the United States.
- Moisture transmission of brick walls.
- Physical properties and performance of brick-masonry structures.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
- Thermal expansion of refractory oxides.
- Heat conductance of certain refractories.
- Behavior of certain refractories in service.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
- Thermal and electrical conductivities of refractories at high temperatures.

Wittenburg College, Department of Chemistry, Springfield, Ohio.
- Preparation of dolomitic refractories.

III. Porcelain, Enamels, Glass and Electrical Insulators

Allen-Bradley Co., Milwaukee, Wis.
- Utilization of clay and similar minerals for electrical insulation.

American Chemical Products Co., 7 Litchfield Street, Rochester, N. Y.
- Use of selenium salts in the glass industry.

American Dental Association (in cooperation with the United States Bureau of Standards), 58 East Washington Street, Chicago, Ill.
- Study of dental materials.

American Gas Association, Committee on Industrial Gas Research (in cooperation with Rutgers University), 420 Lexington Avenue, New York, N. Y.
- Improving practices and efficiencies in the application of gas in the ceramics industry.

American Society for Testing Materials (in cooperation with the Bell Telephone Laboratories, and the General Electric Co.), 1315 Spruce Street, Philadelphia, Pa.
Properties of electrical slate.

American Society for Testing Materials (in cooperation with the National Slate Association and the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Abrasive hardness of slate.

American Window Glass Co., Farmer's Bank Building, Pittsburgh, Pa.
Selection of correct clay for the specific purpose of glass manufacturing, and the development of the best process for making the clay of maximum utility.

Anaconda Lead Products Co., 151st and McCook Avenues, East Chicago, Ind.
Lead compounds for glass making.

Bailey & Sharp Co., Hamburg, N. Y.
Utilization of bismuth in glass.

Bell Telephone Laboratories (Inc.) (in cooperation with the American Society for Testing Materials and the General Electric Co.), New York, N. Y.
Properties of electrical slate.

C. G. Buchanan Chemical Co., Baker Avenue, Norwood, Cincinnati, Ohio.
Cleaning of glass for lacquering and decalcomania.

Condit Electrical Manufacturing Corporation, 1344 Hyde Park Avenue, Hyde Park, Mass.
Fibrous and ceramic insulating materials used in electrical apparatus and machinery, such as laminated, wound, or pressed phenolic materials, porcelain bushings and insulators.

Corning Glass Works, Corning, N. Y.
Development of glass to meet particular needs.
Development of refractories for glass containers.
Properties of glass of various compositions, including viscosity, density, expansion, and stability.
Control of raw batch materials entering into glass batches to insure a uniform glass product.
More effective utilization of gas, coal and oil in the manufacture of glass.

The Dorr Co., 247 Park Avenue, New York, N. Y.
Glass sand purification.

Duplate Corporation, Creighton, Pa.
Research on safety glass.

Ferro Enamel Corporation, Cleveland, Ohio.
Fundamental reactions involved in the manufacture of enamel.

Ford Motor Co., Dearborn, Mich.
Production of glass sand from lime-bonded sandstone.

Fostoria Glass Co., Moundsville, W. Va.
Cerium glasses.
Selenium in glasses.

General Electric Co., Research Laboratory, Schenectady, N. Y.
Making insulators of pure refractory oxides for vacuum tubes.
Examination of and experimentation with mineral substances for use in ceramic products such as porcelain and vitreous enamels.
Production and utilization of ceramic insulators and enamels.

General Electric Co. (in cooperation with the American Society for Testing Materials and the Bell Telephone Laboratories), 1 River Road, Schenectady, N.Y.
Properties of electrical slate.

Harrop Ceramic Service Co., 310 West Broad Street, Columbus, Ohio.
Drying, firing, and glazing of ceramic products.
Preparation of colored clay granules.

The Hazel-Atlas Glass Co., Clarksburg, W. Va.
A cheap decolorizer for glass carrying over 0.10 Fe_2O_3.
A reliable breakage test for glassware used in hot processing.

University of Illinois, Department of Ceramic Engineering, Urbana, Ill.
Electrical porcelain investigation.
Effect of atmospheric conditions on cast-iron and sheet-steel enamels in melting and firing.
Nature of opacifiers in enamels as shown by X-ray studies.
Effect of body composition on development of salt glazes.
Microscopic studies of porcelain glazes.

University of Illinois (in cooperation with the Utilities Research Commission (Inc.)), Urbana, Ill.
High voltage porcelain insulators.

Lafayette College, Department of Electrical Engineering, Easton, Pa.
Tests of slate for electrical purposes.

Lapp Insulator Co., Le Roy, N. Y.
Tests of electrical porcelain bodies and clays.
Tests of firing in tunnel kiln.
Tests of strength of insulating materials.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Study of ceramic finishes and their preparation for use on sanitary ware.
Development of single-coat enamel for enamel ware.

McGean Chemical Co., Keith Building, Cleveland, Ohio.
    Development of vitreous enamels.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
    Production problems in the manufacture of glass.
    Problems in the production of insulating glass.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
    Transmission and diffusion of light by glass.

National Slate Association (in cooperation with the American Society for Testing Materials and the United States Bureau of Standards), Drexel Building, Philadelphia, Pa.
    Abrasive hardness of slate.

University of Nebraska, Lincoln, Neb.
    Prospecting for glass sand.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
    A fundamental study of vitreous enamels.

Onondaga Pottery Co., Laboratory, 1858 West Fayette Street, Syracuse, N. Y.
    Production of improved type of chinaware.
    Effecting economies in chinaware manufacture.

The Pfeudler Co., 89 East Avenue, Rochester, N. Y.
    Research on vitreous linings for steel equipment.

Pittsburgh Plate Glass Co., Window Glass Research Department, Mt. Vernon, Ohio.
    Study of desirable temperature for melting and fabricating window glass.
    Study to permit control of materials for window glass with respect to purity, grain size, and constancy of composition.

Louis G. Robinson Laboratories, 21 East 4th Street, Cincinnati, Ohio.
    Development of acid-resisting enamels.

Rundle Manufacturing Co., Milwaukee, Wis.
    Dry process cast-iron enameling.

Rutgers University (in cooperation with the American Gas Association), New Brunswick, N. J.
    Improving practices and efficiencies in the application of gas in the ceramics industry.

Foster D. Snell, Consulting Chemist, 130 Clinton Street, Brooklyn, N. Y.
    Suspension of suitable glass-insoluble abrasives in molten glass in the manufacture of abrasive glass.

Splitdorf Electrical Co., Newark, N. J.
Electrical porcelain and glazes therefor, resistant to high temperature.
Mineral-insulating compounds adapted to commercial moulding.

Stackpole Carbon Co., Tannery Street, St. Marys, Pa.
Development and perfection of nonmetallic high-resistance units for radio work.

Stanford University, Stanford University, Calif.
The beneficiation of glass sands.

United States Bureau of Standards, Washington, D. C.
Effect of high temperatures on micas.
Problems relating to the manufacture of optical glass.
Factors affecting the crazing of semiporcelain dinner ware.
The physical properties of vitreous china bodies fired at different temperatures.
Development and improvement of methods for the chemical analysis of glass sand.

United States Bureau of Standards (in cooperation with the American Dental Association), Washington, D. C.
Study of dental materials.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials and the National Slate Association), Washington, D. C.
Abrasive hardness of slate.

Utilities Research Commission (Inc.) (in cooperation with the University of Illinois), Room 523, 72 West Adams Street, Chicago, Ill.
High-voltage porcelain insulators.

R. T. Vanderbilt Co. (Inc.), 230 Park Avenue, New York, N. Y., Laboratory at 33 Winfield Street, East Norwalk, Conn.
Use of pyrophyllite in ceramic bodies.
Use of cerium oxide to make yellow glass.

Vitrefrax Corporation, 5050 Pacific Boulevard, Los Angeles, Calif.
Development of long-range ceramic fluxes.

Wayne Laboratories, 17 East Main Street, Waynesboro, Pa.
Development of permanent colors on rock granules by a firing process and by coating the granules.

IV. Porous Ceramic Products, Heat Insulators, and Asbestos

American Society of Heating and Ventilating Engineers, Research Laboratory (in cooperation with the University of Minnesota), 4800 Forbes Street, Pittsburgh, Pa.
Heat transmission through various types of building construction.

American Solvents and Chemical Corporation, 122 East 42nd Street, New York, N.Y.
85 per cent magnesia and other heat insulating materials.

Armour Institute of Technology, Mechanical Engineering Department, Chicago, Ill.
Heat transmission through building materials, insulating materials, pipe coverings and refractories.

Armstrong Cork Co., Lancaster, Pa.
The utilization of clays, diatomaceous earth, and asbestos in the production of thermal insulating materials.

Brown University, Division of Engineering, Providence, R. I.
Investigation of insulating properties of certain materials.

C. F. Burgess Laboratories (Inc.), 1011 East Washington Avenue, Madison, Wis.
Development of porous and light-weight ceramic products.

Philip Carey Co. (in cooperation with the Mellon Institute of Industrial Research), Lockland, Ohio.
Fellowship on heat insulation.

Dewey & Almy Chemical Co., 235 Harvey Street, North Cambridge, Mass.
Grading of asbestos.
Freeing of asbestos from grit.
Asbestos as a friction element.

Gladding, McBean & Co., 2901 Los Feliz Boulevard, Los Angeles, Calif.
Study of porous burned-clay bodies.

Johns-Manville Corporation (Celite Corporation), Lompoc, Calif.
The development of methods for prospecting, mining, quarrying, and stripping deposits of diatomaceous silica in Santa Barbara County, Calif.
The transportation and processing of diatomaceous silica.

Johns-Manville Corporation, Manville, N. J.
The development of light-weight ceramic products for heat and sound insulation.
The processing of diatomaceous silica and the use of products made therefrom for heat and cold insulations.

University of Kentucky, Department of Mines and Metallurgy, Lexington, Ky.
A study of vermiculite, with especial reference to its economic applications.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Utilization of nonmetallic materials in heat insulation.

Mellon Institute of Industrial Research (in cooperation with the Philip Carey Co.), Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Fellowship on heat insulation.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Studies of the use of asbestos in gaskets.

University of Minnesota, Experimental Engineering Laboratories, Minneapolis, Minn.
Determination of the laws governing heat flow through built-up wall sections and insulating materials.

University of Minnesota (in cooperation with the American Society of Heating and Ventilating Engineers), Minneapolis, Minn.
Heat transmission through various types of building construction.

Missouri School of Mines and Metallurgy, Department of Ceramic Engineering, Rolla, Mo.
Development of a high-temperature insulating brick with the use of metals and acids.

Monmouth College, Department of Physics and Geology, Monmouth, Ill.
High-temperature heat insulators.
Plasticization of pure silica.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Development of porous ceramic material.
Developing cellular clay products.

Pennsylvania State College, State College, Pa.
Heat transmission through building materials.

Raybestos-Manhattan (Inc.), Raybestos Division, Bridgeport, Conn.
Manufacture of asbestos products from crude asbestos and fibres.

The Russell Manufacturing Co. (Inc.), Middletown, Conn.
Use of asbestos in textiles.

V. Lime, Gypsum and Plaster

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
- Consistency of gypsum plaster.
- Time of set of gypsum neat plaster.
- Sand content of set gypsum plaster.
- Volume changes in neat gypsum and gypsum-fiber concrete.
- Properties of gypsum-fiber concrete.

California Chemical Corporation, Newark, Calif.
- Preparation and properties of lime from San Francisco Bay oyster shells.

Certain-teed Products Corporation, 100 East 42nd Street, New York, N.Y.
- Utilization of gypsum, calcined gypsum, and their manufactured products.
- Improvement of the qualities of finished gypsum products.
- Improvements of processes for gypsum fabrication.
- Research on raw materials and equipment for making gypsum products.

Cosma Laboratories Co., 1545 East 18th Street, Cleveland, Ohio.
- Development of sound absorbing plaster.

The Haden Lime Co., 1720 Shepherd Street, Houston, Tex.
- Removal of mechanically contained impurities from raw material fed to rotary limekilns.
- Proper size, or gradation of sizes, of raw material to give best results in rotary limekilns.
- Effects of different burning conditions upon properties of lime produced by rotary kilns.
- Effects of properties of quicklime upon the properties of hydrates made from it.
- Effects of different conditions of hydration upon the properties of hydrated limes made from a given grade of quicklime.
- Effects of varying amounts of excess moisture in raw hydrates upon efficiency of milling operations employed to produce finished hydrates and upon the properties of the finished hydrates.

Harrop Ceramic Service Co., 310 West Broad Street, Columbus, Ohio.
- Use of natural gas for firing lime.

University of Illinois, Agricultural Experiment Station, Urbana, Ill.
- Liming materials for use on Illinois soils.
- Relation of soil calcium and magnesium in their different chemical combinations to lime requirement and to hydrogen-ion concentration of the soil, and the movement of these elements in limed and unlimed land.
- Effectiveness of lime and limestone on soils of Illinois.
- Soil acidity and distribution of calcium and magnesium in the horizons of limed and unlimed soils.
- Factors influencing the effectiveness of limestone when used on Illinois soils.

University of Maryland, Agricultural Experiment Station, College Park, Md.
Phosphates, potash, sulphur, lime, boron and other chemicals as plant foods.

Massachusetts Agricultural College, Experiment Station, Amherst, Mass.
Use of potash and lime in fertilizers.

The Mead Corporation, Chillicothe, Ohio.
Utilization of waste lime from the causticizing of alkaline liquors, especially the production of a precipitate suitable for coating paper or as a filler for paper.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Volume changes in gypsum structures due to atmospheric humidity.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Chemical study of commercial lime.

Oklahoma Agricultural Experiment Station, Stillwater, Okla.
The effect of fineness of division and of different amounts of limestone on the growth of alfalfa and other legumes when grown on soils of different degrees of acidity.

Oregon Agricultural Experiment Station, Soils Department, Corvallis, Oreg.
Use of ground limestone for correcting soil acidity.
Use of land-plaster and sulphur as a fertilizer material.
The use of land-plaster and sulphur as a soil amendment on alkali soils.

Pennsylvania Agricultural Experiment Station, State College, Pa.
The value of blast furnace slag as a source of agricultural lime.

Rhode Island Agricultural Experiment Station, Kingston, R. I.
Use of lime for plant growth.

Rutgers University, The College of Agriculture, New Brunswick, N. J.
Use of fertilizers including phosphates, limestones, marls, potash minerals, nitrates, sulphur, and ammonium salts.

Foster D. Snell, Consulting Chemist, 130 Clinton Street, Brooklyn, N. Y.
Methods for the most satisfactory slacking of burnt lime and for improving it for use in mortar or plaster by rendering it quicker-setting and less porous.
The reduction of suction in plasters.
Precast building material from magnesite in imitation of the surface texture and appearance of travertine.

Structural Gypsum Corporation, Linden, N. J.
Fundamental properties of gypsum.
Development of new products from gypsum.
Improvement of present gypsum products.

United States Bureau of Mines, Nonmetallic Minerals Experiment Station (in cooperation with Rutgers University), New Brunswick, N. J.
Fundamental factors involved in the utilization of gypsum and anhydrite for cement retardation.

United States Bureau of Standards, Washington, D. C.
Determination of the particle-size distribution of hydrated lime.
Determination of the soundness of lime.
Freezing and thawing tests on sand-lime brick.
The burning of a chalk containing diatomaceous silica for the production of an hydraulic lime.
Volumetric changes of gypsum-fiber concrete.
Heat of solution of calcium sulphate.

United States Geological Survey, Washington, D. C.
Regional studies, distribution, character, amount, and geological relations of gypsum.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
Effect of storage on hydrated lime.
Comparative efficiency of various cements and lime in mortars.

Warner Co., 1616 Walnut Street, Philadelphia, Pa.
Quick-set plaster with lime base.
Plastic hydrate from a normally nonplastic lime.

Weld and Liddell, 75 West Street, New York, N. Y.
Production of magnesite plastics.

University of Wisconsin, Agricultural Experiment Station, Madison, Wis.
The value of lime phosphate as a fertilizer.

VI. Cement and Concrete
(including aggregates)

University of Alabama, University, Ala.
Determination of temperatures occurring in concrete after placing.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.
Efficient grinding of cement-making materials, Portland-cement clinker, and other materials.
Determination of optimum particle size of Portland cement.

American Association of State Highway Officials (in cooperation with the Missouri State Highway Department), National Press Building, Washington, D.C.
Standardization of method for determining flexural strength of plain concrete.

American Concrete Institute, 624 Fisher Building, Detroit, Mich.
The fundamental relationships between load, elastic properties and ultimate strength of reinforced-concrete columns as influenced by variations in size, quality of concrete, curing of concrete, amount, arrangement and quality of reinforcement, fireproofing, rate and method of loading, and the effect of continuous loading over long periods of time.

American Society of Civil Engineers (in cooperation with the American Society for Testing Materials and the Iowa State Highway Commission), 33 West 39th Street, New York, N. Y.
Comparative strength tests of cement.

American Society of Civil Engineers (in cooperation with the Engineering Foundation, the University of Illinois, the Ohio State University, and the United States Bureau of Public Roads), 33 West 39th Street, New York, N. Y.
Concrete and reinforced-concrete arches.

American Society of Heating and Ventilating Engineers, Research Laboratory, 4800 Forbes Street, Pittsburgh, Pa.
Effect of aging on conductivity of concrete.

American Society for Testing Materials (in cooperation with the American Society of Civil Engineers and the Iowa State Highway Commission), 1315 Spruce Street, Philadelphia, Pa.
Comparative strength tests of cement.

American Society for Testing Materials (in cooperation with the Ash Grove Lime and Portland Cement Co., and the Kansas State Agricultural College), 1315 Spruce Street, Philadelphia, Pa.
Permeability tests of concrete.

American Society for Testing Materials (in cooperation with the University of California), 1315 Spruce Street, Philadelphia, Pa.
Standard method of test for determining volume changes in concrete, and effect of volume changes upon the durability of concrete.

American Society for Testing Materials (in cooperation with the France Stone Co., the Ohio State Highway Department, and the United States Bureau of Public Roads), 1315 Spruce Street, Philadelphia, Pa.
Abrasion of aggregates.

American Society for Testing Materials (in cooperation with the University of Illinois, the Port of New York Authority, and the United States Bureau of Public Roads), 1315 Spruce Street, Philadelphia, Pa.
Quality of concrete for bridge floor slabs, with special reference to the use of light-weight aggregates.

American Society for Testing Materials (in cooperation with the Indiana State Highway Commission), 1315 Spruce Street, Philadelphia, Pa.
Effect of oil-bearing aggregates on concrete.

American Society for Testing Materials (in cooperation with the Iowa State College of Agriculture and Mechanic Arts, Lehigh University, Portland Cement Association and the Tennessee State Highway Department), 1315 Spruce Street, Philadelphia, Pa.
Investigation of the accuracy and practicability of various proposed methods of measuring the constituents of fresh concrete.

American Society for Testing Materials (in cooperation with Iowa State College of Agriculture and Mechanic Arts, and the Tennessee State Highway Department), 1315 Spruce Street, Philadelphia, Pa.
Uniformity of apparent specific gravity of fine and coarse aggregate from same deposit.

American Society for Testing Materials (in cooperation with the Iowa State Highway Commission, the Kansas State Agricultural College, and the Minnesota Highway Department), 1315 Spruce Street, Philadelphia, Pa.
Effect of rate of freezing for freezing and thawing tests of aggregates.

American Society for Testing Materials (in cooperation with the Iowa State Highway Commission, the Kansas State Agricultural College, the National Crushed Stone Association, the National Sand and Gravel Association, the New York State Highway Commission, the Portland Cement Association, and the United States Bureau of Public Roads), 1315 Spruce Street, Philadelphia, Pa.
Soundness of aggregate.

American Society for Testing Materials (in cooperation with the Johns-Manville Corporation and the Portland Cement Association), 1315 Spruce Street, Philadelphia, Pa.
Workability of concrete.

American Society for Testing Materials (in cooperation with the Kansas State Agricultural College), 1315 Spruce Street, Philadelphia, Pa.
Laboratory tests of the probable cause of failure of concrete.
Volume changes in concrete made with high-early-strength and standard Portland cements.

American Society for Testing Materials (in cooperation with the National Crushed Stone Association, the National Slag Association, and the National Sand and Gravel Association), 1315 Spruce Street, Philadelphia, Pa.
Suitability of stone sand, slag sand, and crushed-gravel sand for use as fine aggregate in concrete.

American Society for Testing Materials (in cooperation with the New Hampshire Highway Department), 1315 Spruce Street, Philadelphia, Pa.
Studies of workability of concrete contributing to the formation of specifications for aggregates.

American Society for Testing Materials (in cooperation with the New Jersey State Highway Department), 1315 Spruce Street, Philadelphia, Pa.
Comparison of different methods of testing concrete sands to secure a standard method.

American Society for Testing Materials (in cooperation with the Oregon Agricultural College), 1315 Spruce Street, Philadelphia, Pa.
Study of various recommended methods for determining moisture content in concrete aggregate.

American Society for Testing Materials (in cooperation with the Portland Cement Association), 1315 Spruce Street, Philadelphia, Pa.
Durability of concrete in relation to compressive strength, different water-cement ratios, and consistencies.
Development of methods of tests for measuring the durability of concrete.

American Society for Testing Materials (in cooperation with the Tennessee State Highway Department), 1315 Spruce Street, Philadelphia, Pa.
Method for determining the apparent specific gravity of coarse aggregate.

American Society for Testing Materials (in cooperation with the United States Bureau of Public Roads), 1315 Spruce Street, Philadelphia, Pa.
Effect of moisture conditions at test on stress-strain relation for concrete in compression and flexure.
Proposed alternate method of mortar test for sand for use in fine aggregate.
Standardization method for the determination of flexural strength of concrete.

American Society for Testing Materials (in cooperation with the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Weathering characteristics of concrete.

Ash Grove Lime and Portland Cement Co. (in cooperation with the American Society for Testing Materials and the Kansas State Agricultural College), Chanute, Kans.
Permeability tests of concrete.

Atlas Lumnite Cement Co., 135 East 42nd Street, New York, N. Y.
Properties of calcium aluminate cement in mortar and concrete, in concrete construction, in resistance to corrosive action of alkaline sulphate solutions, and for refractory uses.

Babcock & Wilcox Co., 85 Liberty Street, New York, N. Y.
Development of high temperature cements and plastics for use in furnaces.

Birmingham-Southern College, Department of Chemistry, Birmingham, Ala.
Relation of composition and fineness to the properties of blast furnace slag cements.
Physical and chemical properties of puzzolanic cements.

Calcium Chloride Association (in cooperation with Ohio State University), 61 Broadway, New York, N. Y.
The effect of calcium chloride as a curing agent for Portland-cement concrete.
Effect of calcium chloride on hydration of minerals.

California Agricultural Experiment Station, Davis, Calif.
Comparative field and accelerated use tests of fence posts made from steel, wood treated with various preservatives, and concrete of various mixtures, reinforcing, and methods of wire fastening.

California Division of Highways, Sacramento, Calif.
Effect of additions of various commercial powders on the properties of cement mortars and concretes.
Effect of copper sulphate on asphalt and asphalt-concrete mixtures.
Efficacy of various methods of curing concrete pavements.
The expansion and contraction of concrete pavements.
Hydration and causes of disintegration of concrete.
Investigation of strengths of different brands of cements.
Permissible tolerance of soft rock in concrete coarse aggregate.

University of California, Berkeley, Calif.
Comparison of compressive strength and modulus of rupture.
Effect of high-curing temperature on strength of concrete.
Effect of jigging during setting on compressive strength of concrete.
Effect of moisture on strength and modulus of elasticity of concrete.
Effect of size of cylinder on strength of concrete.
Effect of temperature at time of test on strength of concrete.
Flexural strength of brick and tile masonry beams using a variety of cement-lime mortars.
Permeability of concrete.
Thermal expansion of concrete.
Volume changes in concrete due to changes in moisture conditions.

University of California, Department of Mining and Metallurgy, Berkeley, Calif.
The effects of pressure, temperature, and dilution on the setting properties and strength of oil-well cements.

University of California (in cooperation with the Engineering Foundation), Berkeley, Calif.
Plastic flow of concrete under continued stress.

University of California, College of Civil Engineering (in cooperation with the American Society for Testing Materials), Berkeley, Calif.
Standard method of test for determining volume changes in concrete, and effect of volume changes upon the durability of concrete.

The Citadel, The Military College of South Carolina, Charleston, S. C.
Effect of diatomaceous silica on the water-cement ratio of concrete.

University of Colorado, Boulder, Colo.
Effect of removing water that gathers at the top of the mortar or concrete soon after placing.
Effect of size of cylinder on strength of concrete and mortars.
Effect of stressing steel encased in concrete above its yield point.
Effect of crusher dust on the strength and other properties of mortars and concretes made from crushed granite.
Effect of colloidal clay in sand on its usefulness as a fine aggregate for concrete.
Well-graded washed sand versus crushed granite screenings as fine aggregates for concrete.
Celite as an admixture in concrete.

University of Colorado (in cooperation with the United States Bureau of Reclamation and the Engineering Foundation), Boulder, Colo.
Rates of evaporation and absorption of mortar and concrete specimens of different sizes and shapes.
Flow of concrete under continuous compressive, flexural, and tensile stress.
Modulus of elasticity and Poisson's ratio of concrete.
Modulus of elasticity in tension, torsion, and flexure of concrete.
Volume changes in concrete due to changes in moisture conditions.

Consolidated Gas, Electric Light & Power Co., Baltimore, Md.
Effect on concrete of acid water from stored bituminous coal.

Hugh L. Cooper & Co. (Inc.) (in cooperation with the United States Bureau of Standards), 101 Park Avenue, New York, N. Y.
Effect of clays in concrete.

Coplay Cement Manufacturing Co., Coplay, Pa.
Burning and grinding problems in the manufacture of Portland cement.

Delaware, Lackawanna & Western Railway Co., Hoboken, N. J.
Effect of admixtures on concrete.

Detroit Edison Co., 2000 Second Avenue, Detroit, Mich.
Effect of sulphur water on concrete.
Oilproofing concrete.

Engineering Foundation (in cooperation with the American Society of Civil Engineers, the University of Illinois, the Ohio State University, and the United States Bureau of Public Roads), 29 West 39th Street, New York, N. Y.
Concrete and reinforced-concrete arches.

Engineering Foundation (in cooperation with the University of California), 29 West 39th Street, New York, N. Y.
Plastic flow of concrete under continued stress.

Engineering Foundation, Arch Dam Committee (in cooperation with the United States Bureau of Reclamation and the University of Colorado), 29 West 39th Street, New York, N. Y.
Rates of evaporation and absorption of mortar and concrete specimens of different sizes and shapes.
Flow of concrete under continuous compressive, flexural, and tensile stress.
Modulus of elasticity and Poisson's ratio of concrete.
Modulus of elasticity in tension, torsion, and flexure of concrete.
Volume changes in concrete due to changes in moisture conditions.

France Stone Co. (in cooperation with the American Society for Testing Materials and others), 816 Summit Street, Toledo, Ohio.
Abrasion of aggregates.

Georgia State Highway Department, Atlanta, Ga.
Internal stress and longitudinal movement of concrete paving.

Illinois State Highway Department, Springfield, Ill.
A comparison of the strength making properties of 14 brands of standard Portland cement used in the construction of highways in Illinois.
The effect of various percentages of different powdered admixtures upon the strength and workability of concrete.
The weather-resisting qualities of concrete in which different percentages of chert were used as a coarse aggregate.

University of Illinois, Urbana, Ill.
Bond resistance of reinforced concrete beams under continued load.

University of Illinois (in cooperation with the American Society of Civil Engineers, the Engineering Foundation and others), Urbana, Ill.
Concrete and reinforced-concrete arches.

University of Illinois (in cooperation with the American Society for Testing Materials and others), Urbana, Ill.
Quality of concrete for bridge floor slabs, with special reference to the use of light-weight aggregates.

Indiana State Highway Commission, Indianapolis, Ind.
Cracking and surface conditions of Portland-cement concrete pavements of various types and ages.

Indiana State Highway Commission (in cooperation with the American Society for Testing Materials), Indianapolis, Ind.
Effect of oil-bearing aggregates on concrete.

International Cement Corporation, 342 Madison Avenue, New York, N. Y.
Effect of temperature environment on strength and other properties of concrete made from high-early-strength Portland cement.
Properties of concrete consolidated under high pressure.
Effect of compound composition on manufacture and properties of Portland cement and high-early-strength Portland cement.
Factors affecting workability of concrete mixtures.
Concrete-making properties of high-early-strength Portland cements.

Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.
Making high-temperature cements from scrap refractories.
Methods of rendering concrete drain tile resistant to alkali attack.

Iowa State College of Agriculture and Mechanic Arts, Department of Civil Engineering (in cooperation with the American Society for Testing Materials and others), Ames, Iowa.
Uniformity of apparent specific gravity of fine and coarse aggregate from same deposit.
Investigation of the accuracy and practicability of various proposed methods of measuring the constituents of fresh concrete.

Iowa State Highway Commission, Laboratory, Ames, Iowa.
Determination of the causes of flash setting or early stiffening of otherwise apparently normal Portland cements.
Development of a new strength test for sand for concrete aggregate.
Effect on the strength and durability of concrete of the use of relatively soft limestone as coarse aggregate.
The effect upon the strength and durability of concrete of calcium chloride solution used in the fabrication of the concrete.
Effect of type of transverse-testing machine on modulus of rupture of concrete.

Iowa State Highway Commission - Continued.
The effects of various commercial admixtures in concrete.
Elastic properties of concrete.
Fatigue tests on concrete.
Investigation of the behavior of different types of stone when subjected to each of several variations of the sodium sulphate soundness test.
Methods of curing concrete.
Thermal coefficient of expansion of concrete.
Waterproofing concrete.

Iowa State Highway Commission, Laboratory, Mason City, Iowa.
Effects of moisture conditions of subgrade upon rate and extent of moisture loss from plastic concrete.

Iowa State Highway Commission (in cooperation with the American Society for Testing Materials and others), Ames, Iowa.
Effect of rate of freezing for freezing and thawing tests of aggregates.
Soundness of aggregates.

Iowa State Highway Commission, Department of Materials and Tests (in cooperation with the American Society for Testing Materials and the American Society of Civil Engineers), Ames, Iowa.
Comparative strength tests of cement.

Johns-Manville Corporation, Manville, N. J.
Research in the processing of diatomaceous silica and in the use of products made therefrom for concrete admixtures.
The development and improvement of refractory cements to meet specific conditions.

Johns-Manville Corporation (in cooperation with the American Society for Testing Materials and the Portland Cement Association), Manville, N. J.
Workability of concrete.

Johns-Manville Corporation (in cooperation with the Pierce Testing Laboratories), Manville, N. J.
Permeability tests of concrete with and without admixtures of celite.

Kansas City Testing Laboratory, 700 Baltimore Avenue, Kansas City, Mo.
Preparation of light-weight aggregates for concrete.

Kansas State Agricultural College, Manhattan, Kans.
The effect of porosity on durability of concrete.
Causes of deterioration of Portland-cement concrete when exposed to action of ensilage liquors and development of methods of overcoming and preventing such deterioration.

Kansas State Agricultural College, Engineering Experiment Station, Manhattan, Kans.
- Short-time strength tests for sands for concrete.
- Use of sand as total aggregate for concrete.
- Durability of aggregates in concrete.

Kansas State Agricultural College (in cooperation with the National Research Council), Manhattan, Kans.
- Volume changes in concrete.

Kansas State Agricultural College, Engineering Experiment Station (in cooperation with the Kansas State Highway Commission), Manhattan, Kans.
- Factors affecting change in volume or length of concrete specimens.
- The characteristics and concrete-making qualities of sands from various commercial sources in Kansas.
- Characteristics of 14 brands of standard Portland cement and four early-strength cements as shown by their chemical analyses, time of set, normal consistency, specific gravity, fineness, tensile strength of mortars, and compressive tests on a 1:1.8:3.2 mix of concrete (by volume).
- Determination of the proper methods for measuring the resistance of concrete and concrete aggregates to weathering and alkali action, particularly freezing and thawing.
- Investigations of the effect of various aggregates and other variables on the modulus of elasticity of concrete and Poisson's ratio.
- Moisture content of concrete.
- The temperature of concrete at various depths in freshly laid pavement, under various curing conditions.

Kansas State Agricultural College, Road Materials Laboratory (in cooperation with the American Society for Testing Materials), Manhattan, Kans.
- Laboratory tests of the probable cause of failure of concrete.
- Volume changes in concrete made with high-early-strength and standard Portland cements.

Kansas State Agricultural College, Road Materials Laboratory (in cooperation with the American Society for Testing Materials and the Ash Grove Lime and Portland Cement Co.), Manhattan, Kans.
- Permeability tests of concrete.

Kansas State Agricultural College, Road Materials Laboratory (in cooperation with the American Society for Testing Materials and others), Manhattan, Kans.
- Effect of rate of freezing for freezing and thawing tests of aggregates.
- Soundness of aggregate.

Kansas State Highway Commission (in cooperation with the Kansas State Agricultural College), Topeka, Kans.

Factors affecting change in volume or length of concrete specimens.

The characteristics and concrete-making qualities of sands from various commercial sources in Kansas.

Characteristics of 14 brands of standard Portland cement and four early-strength cements as shown by their chemical analyses, time of set, normal consistency, specific gravity, fineness, tensile strength of mortars, and compressive tests on a 1:1.8:3.2 mix of concrete (by volume).

Determination of the proper methods for measuring the resistance of concrete and concrete aggregates to weathering and alkali action, particularly freezing and thawing.

Investigations of the effect of various aggregates and other variables on the modulus of elasticity of concrete and Poisson's ratio.

Moisture content of concrete.

The temperature of concrete at various depths in freshly laid pavement, under various curing conditions.

Kentucky State Highway Department, Frankfort, Ky.

Causes and preventions of hair cracking in concrete pavement.

Kentucky State Highway Department (in cooperation with the University of Kentucky), Frankfort, Ky.

Curing concrete pavements.

Relationship between transverse and compressive strength of concrete.

Variations in strength of concrete cylinders due to rodding.

Relationship between cement factor and wear and strength of concrete.

Effect on concrete of mixing coarse screenings with sand which does not meet specifications.

Durability of concrete made from unsound stone.

Sandstone as aggregate in concrete.

Method of testing stability of sandstone for concrete construction.

University of Kentucky (in cooperation with the Kentucky State Highway Department), Lexington, Ky.

Curing concrete pavements.

Relationship between transverse and compressive strength of concrete.

Variations in strength of concrete cylinders due to rodding.

Effect on concrete of mixing coarse screenings with sand which does not meet specifications.

Durability of concrete made from unsound stone.

Sandstone as aggregate in concrete.

Method of testing stability of sandstone for concrete construction.

Relationship between cement factor and wear and strength of concrete.

Lapp Insulator Co., LeRoy, N. Y.

Tests of Portland cement.

Lehigh Portland Cement Co., Young Building, Allentown, Pa.
- Development of a low-priced damp closet for cement testing.
- Effect of coal ash on Portland-cement composition.
- Volume changes of neat cements.

Lehigh University (in cooperation with the American Society for Testing Materials), Bethlehem, Pa.
- Investigation of the accuracy and practicability of various proposed methods of measuring the constituents of fresh concrete.

Lehigh University, Department of Geology (in cooperation with the Pennsylvania Geological Survey, cement companies, and other limestone users), Bethlehem, Pa.
- The occurrence, structural features, origin, utilization and economics of the Pennsylvania limestones of economic importance.

Louisville Cement Corporation of Indiana, Speed, Ind.
- Characteristics and properties of natural cements and products made therefrom.
- Effect of Portland-cement admixtures with natural cements.
- Physical and chemical condition of raw materials and their effect on the resultant Portland cement.
- Plasticity of cements and conditions affecting it.

Maine State Highway Department, Orono, Me.
- Determination of the hardness of sand by a wear test and the durability of sand by daily alternate freezing and thawing of mortar specimens.
- Determination of a unit working stress for hooked reinforcing steel for concrete.

Maine Technology Experiment Station, Orono, Me.
- Hydrogen ion content of sands in relation to their use in concrete.

Maryland State Roads Commission (in cooperation with the United States Bureau of Public Roads), Annapolis, Md.
- The suitability of various materials for resurfacing old concrete pavements.
- Comparative study of wet earth, calcium chloride, and sodium silicate for curing concrete pavements.

Massachusetts State Highway Department, Boston, Mass.
- Comparison of strength of concrete cylinders made at the laboratory with concrete cylinders made in the field.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
- Portland cement fellowship.
- The upper SO_3 limit in Portland cement.

Michigan State Highway Department, Laboratory, Lansing, Mich.
Effect of soft particles of coarse aggregate on the strength and durability of concrete.

University of Michigan, Ann Arbor, Mich.
Development of hair cracks in concrete into structural cracks.
Volume changes in concrete.

Minnesota Highway Department, St. Paul, Minn.
Effect of character of fine aggregate on mortar strength.
Effect of heating aggregates on concrete strength.
Soundness tests on gravel pebbles for concrete.

Minnesota Highway Department, Laboratory, Minneapolis, Minn.
The effect on concrete strength of various methods of curing laboratory specimens.

Minnesota Highway Department (in cooperation with the American Society for Testing Materials and others), St. Paul, Minn.
Effect of rate of freezing for freezing and thawing tests of aggregates.

Missouri Portland Cement Co., St. Louis, Mo.
Closed circuit grinding of limestone and shale.

Missouri School of Mines and Metallurgy, Department of Ceramic Engineering, Rolla, Mo.
The heat-resisting qualities of high-temperature cements when subjected to various preheating treatments.

Missouri State Highway Department, Jefferson City, Mo.
Durability of concrete as measured by freezing and thawing tests.
Loss of moisture from concrete cured by various methods.
The relative service rendered by culverts of corrugated metal pipe, vitrified clay pipe, concrete pipe, and concrete boxes.
Tests on various powdered admixtures for promoting workability of concrete.

Missouri State Highway Department (in coöperation with the American Association of State Highway Officials), Jefferson City, Mo.
Standardization of method of determining flexural strength of concrete.

National Building Units Corporation (in cooperation with the National Cinder Concrete Products Association and the United States Bureau of Standards), 122 East 42nd Street, New York, N. Y.
Cinders or boiler ashes as an aggregate for concrete.

National Cinder Concrete Products Association (in cooperation with the National Building Units Corporation and the United States Bureau of Standards), 1600 Arch Street, Philadelphia, Pa.
Cinders or boiler ashes as an aggregate for concrete.

National Crushed Stone Association, 1735 14th Street, N.W., Washington, D.C.
Aggregates for concrete.

National Crushed Stone Association (in cooperation with the American Society for Testing Materials, the National Slag Association and the National Sand and Gravel Association), 1735 14th Street, N.W., Washington, D.C.
Suitability of stone sand, slag sand, and crushed-gravel sand for use as fine aggregate in concrete.

National Crushed Stone Association (in cooperation with the American Society for Testing Materials and others), 1735 14th Street, N.W., Washington, D.C.
Soundness of aggregate.

National Research Council, Highway Research Board, 2101 B Street, N.W., Washington, D.C.
Use of rail-steel reinforcement in highway construction.

National Research Council, Highway Research Board (in cooperation with Kansas State Agricultural College), 2101 B Street, N.W., Washington, D. C.
Volume changes in concrete.

National Research Council, Highway Research Board (in cooperation with the United States Bureau of Public Roads), 2101 B Street, N.W., Washington, D.C.
Significance of the sodium sulphate tests for concrete aggregates.

National Sand and Gravel Association, 545 Munsey Building, Washington, D.C.
Effect of grading of fine and coarse aggregate on strength of concrete.
Effect of briquet-molding pressure on strength ratio of sand mortars.
Crushing and abrasion tests of gravel for concrete.
Accelerated soundness tests of gravel for concrete.
Effect of mineral composition and shape of particles in coarse aggregate on strength of concrete.
Studies of new markets for sand and gravel.

National Sand and Gravel Association (in cooperation with the American Society for Testing Materials, the National Crushed Stone Association, and the National Slag Association), 545 Munsey Building, Washington, D.C.
Suitability of stone sand, slag sand, and crushed-gravel sand for use as fine aggregate in concrete.

National Sand and Gravel Association (in cooperation with the American Society for Testing Materials and others), 545 Munsey Building, Washington, D.C.
Soundness of aggregate.

National Slag Association, 937 Leader Building, Cleveland, Ohio.
Properties of concretes in which slag has been used as the aggregate.
Development of a test for durability of slag concrete.

National Slag Association (in cooperation with the American Society for Testing Materials, the National Crushed Stone Association, and the National Sand and Gravel Association), 937 Leader Building, Cleveland, Ohio.
Suitability of stone sand, slag sand, and crushed-gravel sand for use as fine aggregate in concrete.

Nazareth Cement Co., Nazareth, Pa.
The physical properties of the compounds resulting from the calcination of argillaceous limestones.
The economics of Portland-cement production.
The use of Portland cement in various industries.

Nevada State Highway Department, Carson City, Nev.
Reliability of 3-day tension tests for cement.

New Hampshire Highway Department (in cooperation with the American Society for Testing Materials), Concord, N. H.
Studies of workability of concrete contributing to the formation of specifications for aggregates.

University of New Hampshire, Durham, N. H.
Flexural tests of plain concrete beams.

New Jersey State Highway Department, Trenton, N. J.
Relative value of different methods now in use for curing concrete pavement.

New Jersey State Highway Department (in cooperation with the American Society for Testing Materials), Trenton, N. J.
Comparison of different methods of testing concrete sands to secure a standard method.

New York Board of Water Supply, New York, N. Y.
Improvement of Portland cement.

Port of New York Authority (in cooperation with the American Society for Testing Materials, the University of Illinois, and the United States Bureau of Public Roads), 80-90 8th Avenue, New York, N. Y.
Quality of concrete for bridge floor slabs with special reference to the use of light-weight aggregates.

New York State Highway Commission, Laboratory, Albany, N. Y.
Rational analysis of sands used as fine aggregate for concrete.
Abrasion tests of sands for concrete.
Sodium sulphate soundness test for fine aggregate for concrete.

New York State Highway Commission (in cooperation with the American Society for Testing Materials and others), Albany, N. Y.
Soundness of aggregate.

Ohio State Highway Department, Testing Laboratory, Engineering Experiment Station, Ohio State University, Columbus, Ohio.
The compressive and beam strength of concrete made with high-early-strength cement.

Ohio State Highway Department (in cooperation with the American Society for Testing Materials and others), Testing Laboratory, Engineering Experiment Station, Ohio State University, Columbus, Ohio.
Abrasion of aggregates.

Ohio State Highway Department (in cooperation with the Standard Slag Co.), Testing Laboratory, Engineering Experiment Station, Ohio State University, Columbus, Ohio.
Relation between abrasion loss of gravel, crushed limestone, crushed slag, and their concrete-making properties.

Ohio State University, Columbus, Ohio.
Plastic flow of concrete.
Workability of concrete.

Ohio State University, Department of Mineralogy, Columbus, Ohio.
Properties of dicalcium silicate.

Ohio State University (in cooperation with the American Society of Civil Engineers, the Engineering Foundation, and others), Columbus, Ohio.
Concrete and reinforced concrete arches.

Ohio State University (in cooperation with the Calcium Chloride Association), Columbus, Ohio.
The effect of calcium chloride as a curing agent for Portland-cement concrete.

Ohio State University, Department of Mineralogy (in cooperation with the Calcium Chloride Association), Columbus, Ohio.
Effect of calcium chloride on hydration of minerals.

Oliver United Filters (Inc.), Federal Reserve Bank Building, San Francisco, Calif.
Filtration (for dewatering) of cement slurry, clay, and other materials.

Oregon State Agricultural College (in cooperation with the American Society for Testing Materials), Corvallis, Oreg.
- Study of various recommended methods for determining moisture content in concrete aggregate.

Oregon Portland Cement Co., Oswego, Oreg.
- Proper calcination of slurry.
- Grinding of clinker to correct grading of size of particles.

Pacific Coast Cement Co., Seattle, Wash.
- Particle-size distribution and its effect on cement.
- Methods of measuring, and means of producing plasticity in cement.
- Handling flue dust from cement plants.
- Quick determination of the composition of the raw cement mix.

Pennsylvania Department of Highways, Harrisburg, Pa.
- Effect of hot cement and hot mixing water on the setting time of Portland cement.
- Effect of time of mix and consistency on strength of concrete.
- Comparison of strength of concrete in which limestone was used as coarse aggregate with that using gravel.
- Efficiency of high-early-strength cement compared with blended standard Portland cement.
- Use of calcium chloride as a curing agent compared with sodium silicate, tar, asphalt, and wet straw.
- Use of diatomaceous earth in concrete.

Pennsylvania Geological Survey (in cooperation with Lehigh University, cement companies, and other limestone users), Harrisburg, Pa.
- The occurrence, structural features, origin, utilization and economics of the Pennsylvania limestones of economic importance.

Pierce Testing Laboratories (in cooperation with the Johns-Manville Corporation), Denver, Colo.
- Permeability tests of concrete with and without admixtures of celite.

Portland Cement Association, Research Laboratory, 33 West Grand Avenue, Chicago, Ill.
- Investigation of factors affecting the strength of concrete.
- Chemical studies of Portland cement.
- Constitution and hardening of Portland cement.
- Fire resistance of walls of concrete-masonry units.
- Permeability studies of concrete.
- Factors affecting volume change of concrete and mortar.

Portland Cement Association (in cooperation with the American Society for Testing Materials), 33 West Grand Avenue, Chicago, Ill.
- Development of methods of test for measuring the durability of concrete.
- Durability of concrete in relation to compressive strength, different water-cement ratios, and consistencies.

Portland Cement Association (in cooperation with the American Society for Testing Materials and the Johns-Manville Corporation), 33 West Grand Avenue, Chicago, Ill.
- Workability of concrete.

Portland Cement Association (in cooperation with the American Society for Testing Materials and others), 33 West Grand Avenue, Chicago, Ill.
- Investigation of the accuracy and practicability of various proposed methods of measuring the constituents of fresh concrete.
- Soundness of aggregate.

Portland Cement Association (in cooperation with the United States Bureau of Standards), 33 West Grand Avenue, Chicago, Ill.
- Effect of composition of cement clinker on the properties of the concrete made therefrom.
- Influence of composition on the volume constancy of specimens of the set cements.
- The chemical phenomenon of set of cement.
- The measurement of rate of set of cement and its influence on the properties of cement.
- The control of set of cement.
- Heat of setting of cement.
- Kinetics and thermodynamics of the hydration or setting process.
- Phase equilibria study of the cement systems.
- The adaptation of the X-ray method to a study of the constitution of Portland cement.

Rensselaer Polytechnic Institute, Troy, N. Y.
- The effect of colloidal clay on the permeability, strength and weathering resistance of concrete.

Riverside Cement Co., 621 South Hope Street, Los Angeles, Calif.
- Effects of composition of cement on its properties.
- Effects of fineness of cement on its properties.
- Studies in fine grinding.

City of Seattle, Engineer's Department (in cooperation with the State of Washington, Department of Highways), Seattle, Wash.
- Studies of the Hunt process of curing concrete.

Singmaster and Breyer, Metallurgical and Chemical Engineers, Room 2831, 420 Lexington Avenue, New York, N. Y.
   Grinding of cement.
   Production of high-lime cement.

Foster D. Snell, Consulting Chemist, 130 Clinton Street, Brooklyn, N. Y.
   Quick-setting acidproof cement for use with acidproof brick in the chemical industries.

Solidon Products (Inc.), Wolf and Water Streets, Philadelphia, Pa.
   Preparation of magnesia cements.

South Dakota State School of Mines, Rapid City, S. Dak.
   The manufacture of cement.

Standard Slag Company (in cooperation with the Ohio State Highway Department), Youngstown, Ohio.
   Relation between abrasion loss of gravel, crushed limestone, crushed slag, and their concrete-making properties.

Superior Portland Cement (Inc.), Concrete, Wash.
   Effect of particle size of components on burnability of cement raw mixtures.

Tennessee State Highway Department (in cooperation with the American Society for Testing Materials), Nashville, Tenn.
   Method for determining the apparent specific gravity of coarse aggregate.

Tennessee State Highway Department (in cooperation with the American Society for Testing Materials and others), Nashville, Tenn.
   Uniformity of apparent specific gravity of fine and coarse aggregate from same deposit.
   Investigation of the accuracy and practicability of various proposed methods of measuring the constituents of fresh concrete.

Agricultural and Mechanical College of Texas, College Station, Tex.
   Effect of methods of curing on strength and wear-resistance of concrete.
   Variations in temperature in plain concrete slabs as affected by type of curing.

United States Bureau of Mines, Nonmetallic Minerals Experiment Station (in cooperation with Rutgers University), New Brunswick, N. J.
   Fundamental factors involved in the utilization of gypsum and anhydrite for cement retardation.

United States Bureau of Public Roads, Washington, D. C.
The effect of quality of cement on quality of concrete.
Effect of character of fine aggregate on flexural strength of mortars.
Methods of determining absorption and free-water content of fine aggregates for concrete.
The relation between abrasion tests on fine aggregates and hardness tests of mortars.
Relation between coarse aggregate content and quality of pavement concrete.
Effect of mineral constituents of sand on the strength and hardness of cement mortars.
Development of abrasion tests of fine and coarse aggregates.
Durabiliity of cement mortars as affected by character of fine aggregate.
The segregation of water in concrete placed in deep forms.
Protective treatment of concrete against alkali and salt-water action.
Effect of method of test and size of coarse aggregate on the uniformity of flexure-test results.
Methods of curing concrete pavements.

United States Bureau of Public Roads (in cooperation with the American Society of Civil Engineers, the Engineering Foundation, and others), Washington, D.C.
Concrete and reinforced-concrete arches.

United States Bureau of Public Roads (in cooperation with the American Society for Testing Materials), Washington, D.C.
Tests for cement.
Standardization method for the determination of flexural strength of concrete.
Proposed alternate method of mortar test for sand for use in fine aggregate.
Effect of moisture conditions at test on stress-strain relation for concrete in compression and flexure.

United States Bureau of Public Roads (in cooperation with the American Society for Testing Materials and others), Washington, D.C.
Quality of concrete for bridge floor slabs with special reference to the use of light-weight aggregates.
Abrasion of aggregates.
Soundness of aggregate.

United States Bureau of Public Roads (in cooperation with the Maryland State Roads Commission), Washington, D.C.
Suitability of various materials for resurfacing old concrete pavements.
Comparative study of wet earth, calcium chloride and sodium silicate for curing concrete pavements.

United States Bureau of Public Roads (in cooperation with the National Research Council), Washington, D.C.
Significance of the sodium sulphate tests for concrete aggregates.

United States Bureau of Reclamation (in cooperation with the University of Colorado and the Engineering Foundation), Washington, D.C.
- Rates of evaporation and absorption of mortar and concrete specimens of different sizes and shapes.
- Flow of concrete under continuous compressive, flexural, and tensile stress.
- Modulus of elasticity and Poisson's ratio of concrete.
- Modulus of elasticity in tension, torsion, and flexure of concrete.
- Volume changes in concrete due to changes in moisture conditions.

United States Bureau of Standards, Washington, D.C.
- Modulus of elasticity and Poisson's ratio of concrete.
- Physical properties of cast stone.
- Hardening of Portland cement at the boiling point of water.
- Effect of boric acid on the clinkering of cement.
- Thermal decomposition of tricalcium silicates.
- Reaction of water on calcium aluminates and calcium aluminate cements.
- Reaction of water on the calcium silicates.
- Properties of high-early-strength cements.
- Study of the workability of Portland-cement pastes and mortars with the object of developing an apparatus for measuring workability.
- Study of preparations used for the waterproofing of concrete.
- The durability of aggregates for use in concrete.
- Testing durability of cement by titration in sugar solution.
- Investigation of aggregate for, and properties of, cinder concrete building units.
- Physical properties of masonry cements and mortars, including plasticity, water-retaining capacity, volume change, workability, and others.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D.C.
- Weathering characteristics of concrete.

United States Bureau of Standards (in cooperation with Hugh L. Cooper and Co.), Washington, D.C.
- Effect of clays in concrete.

United States Bureau of Standards (in cooperation with the National Building Units Corporation and the National Cinder Concrete Products Association), Washington, D.C.
- Cinders or boiler ashes as an aggregate for concrete.

United States Bureau of Standards (in cooperation with the Portland Cement Association), Washington, D.C.
- Effect of composition of cement clinker on the properties of the concrete made therefrom.
- Influence of composition on the volume constancy of specimens of the set cements.
- The chemical phenomenon of set of cement.

United States Bureau of Standards - Continued
- The measurement of rate of set of cement and its influence on the properties of cement.
- The control of set of cement.
- Heat of setting of cement.
- Kinetics and thermodynamics of the hydration or setting process.
- Phase equilibria study of the cement systems.
- The development of the X-ray method to a study of the constitution of Portland cement.

Universal Atlas Cement Co., 208 South La Salle Street, Chicago, Ill.
- Use of cement.

Vermont State Highway Department (in cooperation with the University of Vermont), Montpelier, Vt.
- Concrete pavement strengths.

University of Vermont and State Agricultural College (in cooperation with the Vermont State Highway Department), Burlington, Vt.
- Concrete pavement strengths.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
- Comparative efficiency of various cements and lime in mortars.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
- The elastic properties of concrete.
- The correlation of design and test data for simple reinforced-concrete beams.
- The effect of grading of aggregate on cost of materials for a given strength.

State of Washington, Department of Highways, Olympia, Wash.
- Development of specifications for high-early-strength cements.
- Resistance of concrete to waters of acid reaction.
- Transverse test of concrete.

State of Washington, Department of Highways (in cooperation with the City of Seattle), Olympia, Wash.
- Studies of the Hunt process of curing concrete.

West Virginia State Highway Department, Charleston, W. Va.
- Accelerated corrosion tests on culvert pipe of concrete, cast-iron, and corrugated-iron pipe with different coatings.

Wisconsin Highway Commission, Madison, Wis.
- Comparison of methods of curing concrete pavements.
- Effect of absorption of mixing water in relation to aggregates in designed mixes of concrete.
- The effective age periods of high-early-strength cements.

VII. Sand, Gravel and Crushed Stone
(Aggregates are included under Section C-VI, Cement and Concrete.)

American Foundrymen's Association (in cooperation with Cornell University and and the United States Bureau of Standards), 222 West Adams Street, Chicago, Ill.
Development of test methods and plant control of foundry sands (including molding and core sands).

Anthracite Institute, Laboratory (in cooperation with Lehigh University), Primos, Pa.
Comparative efficiencies of sand and fine anthracite in water purification.

Arkansas Lime Products Co., 501-504 State National Bank Building, Texarkana, Tex.-Ark.
Improvement of limerock for road-base purposes.

Buckeye Steel Castings, Co., Columbus, Ohio.
Molding-sand research.

Certain-teed Products Corporation, York, Pa.
Suitability of crushed silica sand, waste sand (sand-blast sand) and other finely divided materials for use as fillers or aggregates in asphalt coatings on prepared or composition roofing.

Colorado Agricultural Experiment Station, Fort Collins, Colo.
Road materials of Colorado.

Cornell University (in cooperation with the American Foundrymen's Association), Ithaca, N. Y.
Development of standard methods of testing foundry sand.

The Dorr Co., 247 Park Avenue, New York, N. Y.
Glass sand purification.

Electric Steel Founders' Research Group, 541 Diversey Parkway, Chicago, Ill.
Use of core sands and molding sands.

Ford Motor Co., Dearborn, Mich.
Production of glass sand from lime-bonded sandstone.

University of Georgia, Athens, Ga.
Study of sand clay, semigravel, and similar materials for road betterment.

Iowa Geological Survey, Des Moines, Iowa.
Prospecting and mining the molding sands of Iowa.

Kansas State Agricultural College, Engineering Experiment Station, Manhattan, Kans.
Road material resources of Kansas.

Lafayette College, Department of Geology and Geography (in cooperation with the Pennsylvania Geological Survey), Easton, Pa.
Studies of sands and gravels.

Lehigh University (in cooperation with Anthracite Institute), Bethlehem, Pa.
Comparative efficiencies of sand and fine anthracite in water purification.

Maine State Highway Department, Orono, Me.
Determination of the hardness of sand by a wear test.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Rock products fellowship.

Michigan State Highway Department, Laboratory, Ann Arbor, Mich.
Capillary characteristics of typical Michigan sheet-asphalt sands and their effect on stability.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Sand cores for foundry practice.

Missouri State Highway Department (in cooperation with the United States Bureau of Public Roads), Jefferson City, Mo.
Surface materials for low-cost roads.

National Crushed Stone Association, 1735 14th Street, N.W., Washington, D.C.
Stone for railroad ballast.
Aggregates for bituminous road construction.

National Sand and Gravel Association, 545 Munsey Building, Washington, D.C.
Standardization of sizes of sand and gravel.
Results of crushing gravel.
Methods of preventing segregation of sizes.
Studies of new markets for sand and gravel.
Effect of size and grading of sand and gravel on use.
Effect on use of shape and type of particle of sand and gravel.
Studies of soundness and durability of sand and gravel.
Effect of impurities in sand and gravel on use.

University of Nebraska, Lincoln, Neb.
Underground mining of stone.
Prospecting for glass sand.

Nevada State Highway Department, Carson City, Nev.
Relation of grading and specific gravity of aggregates to amount of oil required on bituminous-treated gravel roads.

New York, Ontario, and Western Railroad, Hamilton, N. Y.
Industrial uses of a natural silica sand which passes a 300-mesh sieve.

University of North Carolina, Chapel Hill, N. C.
Development of improved methods of analyzing and classifying filter sands.
Studies on the mechanical analysis of sands.
Mechanical analyses of beach sands and their significance.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Molding sand investigations.

Pennsylvania Geological Survey (in cooperation with Lafayette College), Harrisburg, Pa.
Studies of sands and gravels.

Foster D. Snell, Consulting Chemist, 130 Clinton Street, Brooklyn, N. Y.
Grinding of silica and classification to be suitable for various commercial uses in the abrasive industries.

Stanford University, Stanford University, Calif.
The beneficiation of glass sands.

The Thompson and Lichtner Co. (Inc.), 930 Statler Building, Boston, Mass.
Utilization of special sands occurring with concrete aggregates.
Utilization of sand after employment for glass polishing.

United States Bureau of Public Roads, Washington, D.C.
Bituminous treatment of sandy-soil roads.
Bituminous treatments of crushed-stone and gravel roads.

United States Bureau of Public Roads (in cooperation with the Missouri State Highway Department), Washington, D.C.
Surface materials for low-cost roads.

United States Bureau of Standards, Washington, D.C.
Development and improvement of methods for the chemical analysis of glass sand.

United States Bureau of Standards (in cooperation with the American Foundrymen' Association), Washington, D.C.
Development of standard methods of testing foundry sand.

United States Pipe & Foundry Co., Burlington, N. J.
Sand reclamation.

University of Utah, Utah Engineering Experiment Station, Salt Lake City, Utah.
Determination of the suitability of local sands for foundry purposes.

VIII. Building Stone and Roofing Material

American Society for Testing Materials (in cooperation with Lafayette College, Lehigh University, the National Slate Association, Rensselaer Polytechnic Institute, and the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Methods of determining water absorption of slate.

American Society for Testing Materials (in cooperation with the National Slate Association and Northwestern University), 1315 Spruce Street, Philadelphia, Pa.
Acid and alkali resistance of slate.

American Society for Testing Materials (in cooperation with the National Slate Association and the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Abrasive hardness of slate.

Certain-teed Products Corporation, York, Pa.
Suitability of various nonmetallic substances such as slate-dust, limestone-dust, dolomite, clay, talc, crushed silica sand, waste sand (sand blast sand), and other finely divided materials for use as fillers or aggregates in asphalt coatings on prepared or composition roofings.

Flintkote Co., Rutherford, N. J.
Utilization of granular minerals in roofing.

Harrop Ceramic Service Co., 310 West Broad Street, Columbus, Ohio.
Preparation of colored clay granules.

The James H. Herron Co., 1360 West Third Street, Cleveland, Ohio.
Cleaning sandstone walls of atmospheric dirt.
Treatment of sandstone to prevent soiling or to facilitate cleaning.

Indiana Limestone Co., Bedford, Ind.
Utilizations of limestone by-products.
Physical properties of Bedford limestone.

Lafayette College, Department of Geology and Geography, Easton, Pa.
Investigation of physical properties of slate.

Lafayette College (in cooperation with the American Society for Testing Materials, the National Slate Association, Lehigh University, Rensselaer Polytechnic Institute, and the United States Bureau of Standards), Easton, Pa.
Methods of determining water absorption of slate.

Lehigh University (in cooperation with the American Society for Testing Materials, Lafayette College, the National Slate Association, Rensselaer Polytechnic Institute, and the United States Bureau of Standards), Bethlehem, Pa.
Methods of determining water absorption of slate.

Lehigh University, Department of Geology (in cooperation with the Pennsylvania Geological Survey, cement companies and other limestone users), Bethlehem, Pa.
The occurrence, structural features, origin, utilization and economics of the Pennsylvania limestones of economic importance.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Prevention of discoloration of marble.
Staining marble with various colors.
Preparation of roofing granules from shale and fire clays with simultaneous production of brick.
Study of glazes and colors in ceramic roofing tile.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Roofing fellowship.

National Slate Association (in cooperation with the American Society for Testing Materials, Lafayette College, Lehigh University, Rensselaer Polytechnic Institute, and the United States Bureau of Standards), Drexel Building, Philadelphia, Pa.
Methods of determining water absorption of slate.

National Slate Association (in cooperation with the American Society for Testing Materials and the Northwestern University), Drexel Building, Philadelphia, Pa.
Acid and alkali resistance of slate.

National Slate Association (in cooperation with the American Society for Testing Materials and the United States Bureau of Standards), Drexel Building, Philadelphia, Pa.
Abrasive hardness of slate.

Northwestern University (in cooperation with the American Society for Testing Materials and the National Slate Association), Evanston, Ill.
Acid and alkali resistance of slate.

Pennsylvania Geological Survey (in cooperation with Lehigh University, cement companies, and other limestone users), Harrisburg, Pa.
The occurrence, structural features, origin, utilization and economics of the Pennsylvania limestones of economic importance.

Pennsylvania State College, School of Mineral Industries, Department of Ceramics, State College, Pa.
Development of standard tests for roofing slate.

Rensselaer Polytechnic Institute, Troy, N. Y.
Investigation of the physical properties and weathering of structural slate.

Rensselaer Polytechnic Institute (in cooperation with the American Society for Testing Materials, Lafayette College, Lehigh University, the National Slate Association and the United States Bureau of Standards), Troy, N. Y.
Methods of determining water absorption of slate.

United States Bureau of Standards, Washington, D.C.
Study of the physical properties of cast stone.
Properties of building materials at high temperatures.
Fire tests of roofing materials.
Determination of the weather resistance of various natural stones under various constructional conditions.
Preservation or weatherproofing of natural stone in structures.
Determining the structural fitness or adaptability of natural stone to various uses.
Development and improvement of methods for the chemical analysis of dolomite and limestone.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials, Lafayette College, Lehigh University, the National Slate Association, and Rensselaer Polytechnic Institute), Washington, D.C.
Methods of determining water absorption of slate.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials and the National Slate Association), Washington, D.C.
Abrasive hardness of slate.

United States Geological Survey, Washington, D.C.
Resource and quality of various structural materials such as stone and aggregate.

Vermont Marble Co., Proctor, Vt.
New uses for waste marble.

Wayne Laboratories, 17 East Main Street, Waynesboro, Pa.
Development of permanent colors on rock granules by a firing process and by coating the granules.

IX. Pigments

American Chemical Products Co., 7 Litchfield Street, Rochester, N. Y.
Developing uses for complex acid and salt compounds of tungsten and molybdenum, such as phosphotungstic acid, sodium phosphotungstate, ammonium and sodium phosphotungstates, silicotungstic acid, sodium silicotungstate, ammonium and other silicotungstates, phosphomolybdic acid and ammonium, sodium, and other phosphomolybdates. Fields of use indicated appear to be in the nonfading color preparation, printing colors, and ceramics.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
Physical properties of paint materials.
Hiding power and tinting strength of paint pigments and paints.
Accelerated tests for protective coatings.

Anaconda Lead Products Co., 151st and McCook Avenue, East Chicago, Ind.
Measurement of physical properties of white lead pigments.
Controlling oil absorption of white lead.
Increasing covering power of white lead.
Effect of atmospheric agencies in weathering paint films.
Behavior of paint in container.

C. G. Buchanan Chemical Co., Baker Avenue, Norwood, Cincinnati, Ohio.
Production of ferrous and ferric salts from residues.

California Division of Highways, Sacramento, Calif.
Development of accelerated tests for determining quality of traffic-line lacquers.
Development and investigation of protective coatings for metal surfaces.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
Tests on paints for a variety of protective applications.
Rust inhibitors and neutralizers for addition to water.

Cheesman-Elliot Co., 639 Kent Avenue, Brooklyn, N. Y.
Studies of the possibilities and economies of various mineral products for paint purposes.

The Chemical & Pigment Co. (Inc.), Box 191, Collinsville, Ill.
The manufacture and development of lithopone.

The Eagle-Picher Lead Co., 134 North LaSalle Street, Chicago, Ill.
Production methods for zinc oxide, lead oxides, and white lead (basic lead carbonate and sulphate).
Application of zinc oxide, lead oxides (particularly litharge and red lead), and white lead (basic lead carbonate and sulphate) to customers' uses.

Falls Electric Furnace Corporation, 660 Grant Street, Buffalo, N. Y.
Pigments produced by heat under various atmospheres.

Firestone Tire & Rubber Co., Akron, Ohio.
Evaluation of red oxides for use in coloring rubber products.

The Glidden Co., Cleveland, Ohio.
Prospecting and mining of barytes ore.
Beneficiation of barytes ore for the manufacture of paint.
Manufacture and utilization of cadmium, zinc, and lead pigments.

Grand Rapids Varnish Corporation, 565 Godfrey Avenue, Grand Rapids, Mich.
Utilization of nonferrous minerals such as barytes, aluminum silicate, and silica in the manufacture of paints.

Grasselli Chemical Co., Cleveland, Ohio.
Improvement of processes for manufacturing barium chloride, barium carbonate, and barium sulphate (blanc fixe).
The manufacture and use of cadmium products in pigments.
Manufacture and utilization of zinc oxide of pigment grade.

Illinois State Highway Department, Springfield, Ill.
Durability of paint for steel structures.
Effect of zinc chloride used as a wood preservative on white lead paint applied at a later date.

Institute of Paint and Varnish Research, 2201 New York Avenue, N.W., Washington, D.C.
Development of pigments.

Linfield College, McMinnville, Oreg.
Relation of whiteness to opacity for white pigments in paint and lacquers.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Production of pigments from nonmetallic minerals.

Minnesota State Highway Department, St. Paul, Minn.
Relative durability of different paints.

Mississippi Valley Research Laboratories (Inc.), 660 South 18th Street, St. Louis, Mo.
New process for production of high-grade blanc fixe.
Development of process for extraction of titanium from minerals containing less than 10 per cent of titanium oxide.

Missouri Paint & Varnish Co., 5125 North 2nd Street, St. Louis, Mo.
Rust inhibitive coatings.
Pipe-line and storage-tank coatings and cements (oil, acid, and corrosion resistant).

Missouri School of Mines and Metallurgy, Missouri State Mining Experiment Station, Rolla, Mo.
Concentrating Missouri barite by flotation.

Monmouth College, Department of Physics and Geology, Monmouth, Ill.
Extraction of commercial titanium oxide from titaniferous clays.

The Chas. Moser Co., 215 East 9th Street, Cincinnati, Ohio.
Ferrous minerals and their processing for dry colors.

National Lead Co., Research Laboratories, 105 York Street, Brooklyn, N. Y.
Manufacture of lead oxide and lead arsenate.
Phases of white-lead manufacture.
Microscopic investigation of particle size of pigments.

National Research Council, Highway Research Board, 2101 B Street, N.W., Washington, D.C.
Calcium chloride as a dust palliative.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Mining and utilization of barytes.
Production of zinc pigments from zinc ores.
Utilization of zinc pigments in paint and lacquers, rubber, and ceramics.

Public Service Electric & Gas Co., Newark, N. J.
Accelerated aging tests of paint materials.

Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Engineering, Troy, N. Y.
Investigations of paints and paint pigments.

The Stanley Chemical Co., East Berlin, Conn.
The resistance of pigments to weathering.

Superior Zinc Corporation, Bristol, Pa.
Treatment of zinc residues from chemical plants to produce metal or a marketable grade of zinc oxide.

Synthetic Iron Color Co., Richmond, Calif.
Oxidation of iron in ferrous solutions.
Formation of ultramarine blue.

Syracuse University, Syracuse, N. Y.
The origin and alteration of titanium-bearing minerals, titanite, ilmenite, and rutile.

Titanium Pigment Co. (Inc.), Laboratory, 105 York Street, Brooklyn, N. Y.
Manufacture of titanium pigments and titanium salts from titanium ores.

Toch Brothers (Inc.), 443 Fourth Avenue, New York, N. Y.
Preparation of pigments from ochres, umbers, siennas, and similar earths.
Preparation of pigments from cadmium salts, chromium salts, and similar chemical products.

The Twining Laboratories, 2527 Fresno Street, Fresno, Calif.
Barytes-products and utilization.

R. T. Vanderbilt Co. (Inc.), 230 Park Avenue, New York, N. Y.; Laboratory at 33 Winfield Street, East Norwalk, Conn.
Uses of titanium dioxide (TiO_2).

X. Mineral Fillers, Clarifyers and Detergents.

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.
Revivification of fuller's earth used in contact and percolation methods for purifying oils.

Armstrong Cork Co., Lancaster, Pa.
The utilization of ochre in the manufacture of flooring materials.

Bethlehem Foundry & Machine Co. (Wedge Furnace Department), Bethlehem, Pa.
Drying and calcining (revivifying) filtering and clarifying earths such as fuller's earth and diatomaceous earth for repeated use, notably in filtering lubricating oils and sugar syrups.

Certain-teed Products Corporation, York, Pa.
Suitability of various nonmetallic substances such as slate-dust, limestone-dust, dolomite, clay, talc, crushed silica sand, waste sand (sand blast sand) and other finely divided materials for use as fillers or aggregates in asphalt coatings on prepared or composition roofings.

Drackett Chemical Co., 5020 Spring Grove Avenue, Cincinnati, Ohio.
Study of various mineral products in relation to household cleaning compounds.

The Eagle-Picher Lead Co., 134 North La Salle Street, Chicago, Ill.
Production of zinc oxide and its application to customers' uses, especially in the rubber industry.
Production of lead oxides (particularly litharge and red lead) and their application to customers' uses, including use in rubber, storage battery, oil-refining, ceramic, and chemical industries.
Production of white lead (basic lead carbonate and sulphate) and its application to customers' uses.

Firestone Tire & Rubber Co., Akron, Ohio.
Alumina and silica as compounding ingredients for rubber.

Flintkote Co., Rutherford, N. J.
Clays for emulsification.

University of Florida, College of Pharmacy, Department of Chemistry, Gainesville, Fla.
Chemical and physical tests on Florida clays.

Garfield Manufacturing Co., Garfield, N. J.
Utilization of nonmetallic mineral filler in plastic compositions.
Agglomeration of mineral fillers under pressure.
Preparation and grading of nonmetallic mineral fibrous fillers.

The B. F. Goodrich Co., Akron, Ohio.
The use of various metallic oxides and nonmetallic products in the rubber industry.

Goodyear Tire and Rubber Co., Akron, Ohio.
Study of clays, barytes, and magnesia to produce products suitable for the rubber industry.

Johns-Manville Corporation, Manville, N. J.
The processing of diatomaceous silica and the use of products made therefrom for filtration and fillers.

Kansas City Testing Laboratory, 700 Baltimore Avenue, Kansas City, Mo.
Preparation and utilization of bentonite.

University of Nebraska, Lincoln, Neb.
Prospecting for commercial deposits of volcanic ash.

University of North Carolina, Chapel Hill, N. C.
Development of improved methods of analyzing and classifying filter sands.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum and Natural Gas, State College, Pa.
Investigation of bentonite in Central Pennsylvania.

The Ruberoid Co., 95 Madison Avenue, New York, N. Y.
Use of slate, asbestos, talc, mica, and other minerals as mineral surfacings and fillers.

Sinclair Refining Co., Development Department, East Chicago, Ind.
Reactivation of used contact-treating clays.

Tennessee Copper Co., Copperhill, Tenn.
Preparation of bentonite for oil purification.

Agricultural and Mechanical College of Texas, Department of Geology, College Station, Tex.
Mineralogical study, tests for the identification of, and tests for the value of fuller's earth as a filtering agent.

Texas Pacific Coal & Oil Co., 1710 Ft. Worth National Bank, Ft. Worth, Tex.
Recovery of fine contact clays.

Texas Technological College, Department of Geology, Lubbock, Tex.
Study of volcanic ash deposits of West Texas.

The Twining Laboratories, 2527 Fresno Street, Fresno, Calif.
Pumicite utilization.

United States Bureau of Mines, Northwest Experiment Station (in cooperation with the University of Washington), Seattle, Wash.
Studies of whiting, chalk, and powdered limestone.

United States Geological Survey, Washington, D.C.
Mineralogical and resource studies of bentonite.
Distribution, character, quantity, and possible use of pumicite (volcanic ash).
Distribution, character, amount, geological relationships, and possible utility of diatomaceous earth.

University of Washington (in cooperation with the United States Bureau of Mines), Seattle, Wash.
Studies of whiting, chalk, and powdered limestone.

XI. Acids, Alkalis, Salts, and Sulphur

(See also Section C-XII - Phosphates and Their Derivatives)

Alcoa Ore Co., East St. Louis, Ill.
Increased use of bauxite and refined products in chemical industries.

Aluminum Co. of America, Aluminum Research Laboratories, Box 77, New Kensington, Pa.
Preparation of pure alumina from bauxite and other aluminous materials.

American Potash & Chemical Corporation, Trona, Calif.
  Improvements in process and equipment for extraction of alkali-metal salts from Searles Lake brine by evaporation and fractional crystallization (present products: Borax, boric acid, potassium chloride).
  Phase rule study of complex systems of salts and water, including the Searles Lake system under present equilibrium conditions as well as study of equilibrium at the end-point of crystallization where several new minerals are possible. This study also applies to Owens Lake where at least one new mineral probably exists at present.
  Study of the rate of crystallization, including the crystallization velocity of various faces of a crystal under various conditions of temperature, supersaturation and presence of impurities. This work is chiefly with borax for which definite relations have been found between external conditions and crystal habit.
  Study of the properties of sodium borate minerals and salts, mainly in regard to conditions of stability.
  Development of a process for possible large-scale production of soda ash and anhydrous sodium sulphate.
  Study of possibilities of recovering bromine and lithium from end liquors of potash plant.
  New uses for borax and boric acid.

Armour Fertilizer Works, 111 West Jackson Boulevard, Chicago, Ill.
  Mining and utilizing alunite.

Raymond F. Bacon, 271 Madison Avenue, New York, N. Y.
  Sulphur extraction and utilization.

Blockson Chemical Co., Joliet, Ill.
  Utilization of magnesite for manufacture of epsom salt.

Bucknell University, Lewisburg, Pa.
  The production of alumina and potassium sulphate from alunite.

C. F. Burgess Laboratories, Incorporated, 1011 East Washington Avenue, Madison, Wis.
  Economic recovery of the constituents of bauxites, clays, and other silicates.

California Chemical Corporation, Newark, Calif.
  Production of bromine, potash, magnesium hydrate, carbonate, and oxide from sea-water bittern.
  Preparation and properties of gypsum as a by-product from bittern.

Calumet Chemical Co., Joliet, Ill.
  Extraction and processing Al_2O_3 from sulphuric acid digestion of bauxite ore.

Carus Chemical Co., La Salle, Ill.
Efficient production of manganese salts from manganese ores.

Catholic University of America, Department of Geology, University Station, Washington, D.C.
A study of the ultimate sources of potash.

Detroit Testing Laboratory, 554 Bagley Avenue, Detroit, Mich.
Extraction of potash and borax.

Freeport Sulphur Co., Freeport, Tex.
Removal of carbonaceous matter from molten sulphur.

Georgetown University, 37th and O Streets, N.W., Washington, D.C.
The application of the new allotropic forms of sulphur to vulcanization of rubber.

Grasselli Chemical Co., Cleveland, Ohio.
The utilization of chromium minerals for the manufacture of chromic acid.
Improvement of processes for the utilization of salt in the manufacture of hydrochloric acid.
The improvement of processes for manufacturing sulphuric acid.
The utilization of aluminum-bearing minerals, such as bauxite, in the manufacture of alum and aluminum chloride.
Improvement of processes for manufacturing barium chloride, barium carbonate, and barium sulphate.
The manufacture and use of cadmium products in electroplating, pigments, and other industries.
Utilization of lead acetate.
Improvement of processes for the manufacture of sodium sulphate, sodium bisulphate, and sodium sulphide.
Utilization of sodium silicate.
Industrial utilization of fluorides and silicofluorides.
The manufacture and utilization of zinc chloride and zinc sulphate.
Utilization of lead arsenate, manganese arsenate, calcium arsenate, and barium fluosilicate for spray products and insecticides.
Manufacture of barium fluosilicate from barite, witherite, and apatite.
Manufacture of manganese arsenate from white arsenic and manganese minerals such as pyrolusite and rhodochrosite.
Utilization of strontianite and celestite in the manufacture of strontium nitrate.
The manufacture of tin chloride.

Harvard University, Cambridge, Mass.
Structure studies on a borate mineral.

Illinois State Highway Department, Springfield, Ill.
Effect of zinc chloride used as a wood preservative on white-lead paint applied at a later date.

University of Illinois, Agricultural Experiment Station, Urbana, Ill.
Effect of potassium carriers on soil productivity.
The relation of sulphur to plant nutrition and soil fertility.
Effect of sulphur carriers on soil productivity.

Kansas Geological Survey, Lawrence, Kans.
Isopachus map of the upper Permian salt in Kansas.

Kobbé Laboratories (Inc.), 114 East Thirty-Second Street, New York, N. Y.
Development of new uses for sulphur.

University of Maryland, Agricultural Experiment Station, College Park, Md.
Phosphates, potash, sulphur, lime, boron and other chemicals as plant foods.

Massachusetts Agricultural College, Experiment Station, Amherst, Mass.
Use of potash and lime in fertilizers.

Merrimac Chemical Co. (Inc.), 148 State Street, Boston, Mass.
Sulphate of alumina from clay.
Barium salts from barytes.

Monsanto Chemical Works, 1724 South 2nd Street, St. Louis, Mo.
Manufacture of alum from clay.

University of North Carolina, Chapel Hill, N. C.
Extraction of potassium and of aluminum from feldspar.
Removal of traces of iron from aqueous-salt solutions.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Vacuum evaporation of salt brines.

Oklahoma Agricultural and Mechanical College, Stillwater, Okla.
Survey of the chemical composition of the salt in the salt plains of Oklahoma.

Oregon Agricultural Experiment Station, Soils Department, Corvallis, Oreg.
Use of land plaster and sulphur as a fertilizer material.
The use of land plaster and sulphur as a soil amendment on alkali soils.

Pacific Alkali Co., 1205 Pacific Mutual Building, Los Angeles, Calif.
Method for analysis of solutions containing Na_2CO_3, $NaHCO_3$, $Na_2B_4O_7$, $Na_2B_2O_4$.
The equilibrium constant for the reaction: $H_2O + 2Na_2CO_3 + Na_2B_4O_7 = 2\ Na_2B_2O_4 + 2\ NaHCO_3$.
The activities of Na_2CO_3, $NaHCO_3$, $Na_2B_2O_4$, $Na_2B_4O_7$, Na_2SO_4, $NaClHBO_2$, and Na_2SiO_3 in strong salt solution and their effect on each other.

University of Pennsylvania, 34th and Spruce Streets, Philadelphia, Pa.
Preparation of the oxy salts of magnesium.

Purdue University, Agricultural Experiment Station, Lafayette, Ind.
Role of potassium in plant growth.

Rhode Island Agricultural Experiment Station, Kingston, R. I.
Sources of potash for fertilizers.

University of Rochester, Department of Geology, Rochester, N. Y.
The origin of the salt of New York State.

Rutgers University, The College of Agriculture, New Brunswick, N. J.
Use of insecticides and fungicides containing sulphur.
Use of fertilizers including phosphates, limestones, marls, potash minerals, nitrates, sulphur and ammonium salts.

Ernest Scott & Co., Box 259, Fall River, Mass.
Manufacture of caustic soda and recovery from waste spent liquors.

Solidon Products (Inc.), Wolf and Water Streets, Philadelphia, Pa.
Study of the oxy salts of magnesium that may be produced from calcined magnesite.
Preparation of MgO from magnesite.
Preparation of magnesia cements.

South Dakota State School of Mines, Rapid City, S. Dak.
The extraction of aluminum from clays and other aluminous minerals.

Syracuse University, Department of Chemistry, Syracuse, N. Y.
Decomposition of silicates with alkaline oxides.

Texas Agricultural Experiment Station, College Station, Tex.
Sulphur as a fungicide, insecticide, and soil amendment.
Fertilizers, control measures and field experiments to determine needs of soil for nitrogen, phosphoric acid, and potash.

University of Texas, Bureau of Industrial Chemistry, Austin, Tex.
Refining of polyhalite.

Thiokol Corporation, Yardville, N. J.
Manufacture of a rubber-like substance from ethylene and sulphur and research on rubber and allied plastics.

United States Bureau of Chemistry and Soils, Fertilizer and Fixed Nitrogen Investigations, Washington, D.C.
Extraction of potash from American raw materials.

United States Bureau of Mines, Non-Metallic Minerals Experiment Station, New Brunswick, N. J.
Extraction of potash from polyhalite, greensand, wyomingite, and alunite.
Economic study of processes for the extraction of potash and other valuable products from wyomingite and alunite.

United States Geological Survey, Washington, D.C.
Location, mode of occurrence, extent, quality, and possible tonnage of nitrates in more favorable localities.
Geologic relations, distribution and character of natural sodium salts and to a certain extent the economic features of each deposit.
Location, depth, extent, mineralogical composition and relations, broader geological relations and genesis of potash.
Potash and salt mining methods.

Agricultural College of Utah, Experiment Station, Logan, Utah.
Weed control, using calcium chlorate, sodium chlorate, and magnesium chlorate.
Use of fertilizers, including treble superphosphate, potassium chloride, sulphur, and others.

University of Utah, Salt Lake City, Utah.
Recovery of potash from tailings of porphyry copper properties.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research, Salt Lake City, Utah.
Preparation of chlorate weed killers from bitterns of salt industries located on the Great Salt Lake.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
The manufacture of sulphate from Tazewell County (Virginia) manganese ores.

Virginia Smelting Co., West Norfolk, Va.
Production and use of SO_2 and other chemicals.

Western Precipitation Co., 1016 West Ninth Street, Los Angeles, Calif.
The recovery of potash from cement materials.

University of Wisconsin, Agricultural Experiment Station, Madison, Wis.
The effects of nitrate of soda on the soil.
The needs of Wisconsin soils for potash fertilizer.

XII. Phosphates and Their Derivatives

Alabama Experiment Station, Auburn, Ala.
A comparison of the availability of various phosphates for fertilizer purposes.

American Agricultural Chemical Co., 420 Lexington Avenue, New York, N. Y.
Manufacture of phosphoric acid and phosphates.
Recovery of phosphate rock from debris by screening, classification, tabling, flotation, and electrical induction methods.
Washing and drying phosphate rock.

American Chemical Paint Co., Ambler, Pa.
Preparation and purification of phosphoric acid from phosphate rock.
The discovery of new uses for phosphoric acid and phosphates.
Application of phosphoric acid in metal protection and finishing.

Armour Fertilizer Works, 111 West Jackson Boulevard, Chicago, Ill.
Mining and utilizing phosphate rock.

Blockson Chemical Co., Joliet, Ill.
The manufacture and use of phosphoric acid from phosphate rock by the sulphuric-acid process.

Calumet Chemical Co., Joliet, Ill.
Extraction and processing P_2O_5 from sulphuric acid digestion of Florida pebble phosphate.

General Engineering Co., Salt Lake City, Utah; 50 Broad Street, New York, N.Y.
Investigating the treatment of Florida phosphates.

Grasselli Chemical Co., Cleveland, Ohio.
The manufacture of phosphoric acid, and the utilization of phosphate rock or apatite.
Improvement of processes for the manufacture of phosphates of soda.

Harvard University, Harvard Engineering School, Cambridge, Mass.
Preparation of fertilizer from phosphate rock.

University of Illinois, Agricultural Experiment Station, Urbana, Ill.
Comparison of rock phosphate with acid phosphate in soil bin studies.
Influence of factors affecting the effectiveness of phosphate fertilizers.
Response of Illinois soils to phosphorus.
Factors influencing the value and effectiveness of rock phosphate as a fertilizer.

University of Maryland, Agricultural Experiment Station, College Park, Md.
Phosphates, potash, sulphur, lime, boron, and other chemicals as plant foods.

Montana Agriculture Experiment Station, Bozeman, Mont.
The effect of phosphate fertilizer on yield and phosphate content of forage crops.

University of North Carolina, Chapel Hill, N. C.
Recovery of phosphorus from natural phosphorites by sulphur dioxide.

Pennsylvania Agricultural Experiment Station, State College, Pa.
Field tests of different carriers of phosphorus.

Purdue University, Agricultural Experiment Station, Lafayette, Ind.
Role of phosphorus in plant growth.

Rhode Island Agricultural Experiment Station, Kingston, R. I.
Sources of phosphorus for fertilizers.

F. S. Royster Guano Co., Norfolk, Va.
Treatment of phosphate rock with sulphuric acid to make sulphosphate.

Rutgers University, The College of Agriculture, New Brunswick, N. J.
Use of fertilizers including phosphates, limestones, marls, potash minerals, nitrates, sulphur, and ammonium salts.

Swann Research (Inc.), Anniston, Ala.
Phosphoric acid production and utilization.
Problems in the production of sodium phosphate, mono calcium phosphate, and ammonium phosphate.

University of Tennessee, Agricultural Experiment Station, Knoxville, Tenn.
Comparative value of different phosphates, both alone and in mixtures with ground limestone.
Nature of the combinations that ensue when P_2O_5 is supplied to the soil by acid phosphate with and without supplements of limestone and dolomite.

Texas Agricultural Experiment Station, College Station, Tex.
Fertilizers, control measures, and field experiments to determine needs of soil for nitrogen, phosphoric acid, and potash.

United States Bureau of Chemistry and Soils, Fertilizer, and Fixed Nitrogen Investigations, Washington, D.C.
Technology of phosphate utilization.

United States Bureau of Standards, Washington, D.C.
Development and improvement of methods for the chemical analysis of phosphate rock.

United States Geological Survey, Washington, D.C.
The location, depth, extent, thickness, quality, and classifiable tonnage of the phosphate resources of the western field.

Agricultural College of Utah, Experiment Station, Logan, Utah.
Use of fertilizers, including treble superphosphate, potassium chloride, sulphur, and others.

Victor Chemical Works, 343 South Dearborn Street, Chicago, Ill.
Extraction of phosphorus from phosphate rock in a fuel-fired furnace.
Recovery of phosphorus from ferrophosphorus.
Utilization of phosphorus in the production of phosphorus-containing compounds.

Virginia-Carolina Chemical Corporation, Richmond, Va.
The utilization of phosphate rock in the manufacture of phosphoric acid and fertilizers.
The extraction and processing of phosphate rock.

West Virginia Agricultural Experiment Station, Morgantown, W. Va.
The effects of low-calcium and low-phosphorus rations in growing dairy heifers.

University of Wisconsin, Agricultural Experiment Station, Madison, Wis.
The value of lime phosphate as a fertilizer and as a mineral feed for livestock.
Digest of the world's literature pertaining to phosphorus in relation to soils, fertilizers, and plant life.

XIII. Water, Water Treatment, and Stream Pollution

American Boiler Manufacturers Association (in cooperation with the American Railway Engineering Association, the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Water Works Association, the National Electric Light Association and the Ohio State University), 801 Rockefeller Building, Cleveland, Ohio.
Priming and foaming of boiler waters.

American Railway Engineering Association (in cooperation with the American Boiler Manufacturers Association, the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Water Works Association, the National Electric Light Association and the Ohio State University), 431 South Dearborn Street, Chicago, Ill.
Priming and foaming of boiler waters.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Prevention of stream pollution by development of pickling liquor by-products.

American Society of Mechanical Engineers (in cooperation with the American Boiler Manufacturers Association, the American Railway Engineering Association, the American Society for Testing Materials, the American Water Works Association, the National Electric Light Association and the Ohio State University), 29 West 39th Street, New York, N. Y.
Priming and foaming of boiler waters.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials, the American Water Works Association, the University of Michigan, and the National Electric Light Association), 29 West 39th Street, New York, N. Y.
Development of standard methods for water analysis.

American Society for Testing Materials (in cooperation with the American Boiler Manufacturers Association, the American Railway Engineering Association, the American Society of Mechanical Engineers, the American Water Works Association, the National Electric Light Association and the Ohio State University), 1315 Spruce Street, Philadelphia, Pa.
Priming and foaming of boiler waters.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers, the American Water Works Association, the University of Michigan, and the National Electric Light Association), 1315 Spruce Street, Philadelphia, Pa.
Development of standard methods for water analysis.

American Water Works Association (in cooperation with the American Boiler Manufacturers Association, the American Railway Engineering Association, the American Society of Mechanical Engineers, the American Society for Testing Materials, the National Electric Light Association, and the Ohio State University), 170 Broadway, New York, N. Y.
Priming and foaming of boiler waters.

American Water Works Association (in cooperation with the American Society of Mechanical Engineers, the American Society for Testing Materials, the University of Michigan, and the National Electric Light Association), 170 Broadway, New York, N. Y.
Development of standard methods for water analysis.

Anthracite Institute Laboratory (in cooperation with Lehigh University), Primos, Pa.
Comparative efficiencies of sand and fine anthracite in water purification.

Brooklyn Edison Co. (Inc.), 380 Pearl Street, Brooklyn, N. Y.
Study of conditioning methods for boiler water.

California Filter Co., 981 Folsom Street, San Francisco, Calif.
Boiler-water treatment for high-pressure boilers.
Water purification, color removal, iron removal, and control of slimes.

Detroit Edison Co. (in cooperation with the University of Michigan), Detroit, Mich.
Solubility of calcium sulphate from 0 to 200°C.

Elgin Softener Corporation, 57 North Street, Elgin, Ill.
Synthesizing base-exchange minerals or artificial zeolites.
Preparation and cleaning of greensand for water purification.
Base-exchange properties of galuconite in water softening.
Water purification by natural and synthetic zeolites.
Physicochemical properties of zeolite-treated boiler waters.

Emory University, Department of Physics, Emory University, Ga.
Radioactivity of the waters and rock around Stone Mountain.

Freeport Sulphur Co., Freeport, Tex.
Boiler feed water treatment.
Treatment of discharge water containing sulphides (bleed water) for disposal purposes.

Hall Laboratories (Inc.), Pittsburgh, Pa.
Development of methods for determining hydroxide, carbonate, phosphate, and sulphate content of boiler water and testing adaptability to field practice.
Water conditioning and prevention of corrosion-scale formation and boiler-metal cracking in steam-generating stations.
Investigation of causes of remaining hardness in effluent water from a lime-soda softener.

University of Illinois, Urbana, Ill.
Effect of pressure and temperature on the behavior of salts in boiler-feed water.

Inversand Co., Clayton, N. J.
The manufacture of a water-softening zeolite from greensand.

Lehigh University (in cooperation with Anthracite Institute), Bethlehem, Pa.
Comparative efficiencies of sand and fine anthracite in water purification.

Linfield College, Physics Department, McMinnville, Oreg.
The radioactive properties of certain mineral springs in the neighborhood of McMinnville, Oreg.

University of Michigan, Ann Arbor, Mich.
Formation and properties of boiler scale.
Mechanism of formation of calcium sulphate boiler scale.
Formation and thermal effects of calcium sulphate boiler scale.
Thermal effects of boiler scale.
Crystal forms of calcium sulphate.

University of Michigan (in cooperation with the American Society of Mechanical Engineers, American Society for Testing Materials, National Electric Light Association, and American Water Works Association), Ann Arbor, Mich.
Development of standard methods for water analysis.

University of Michigan (in cooperation with the Detroit Edison Co.), Ann Arbor, Mich.
Solubility of calcium sulphate from 0 to 200°C.

Montana State School of Mines, State Bureau of Mines and Geology, Butte, Mont.
Prospecting for artesian water in eastern and central Montana.

National District Heating Association (in cooperation with the National Tube Co.), 603 South Broadway, Greenville, Ohio.
Effect of impure waters on water supply and steam and hot-water piping.

National Electric Light Association (in cooperation with the American Boiler Manufacturers Association, the American Railway Engineering Association, American Society of Mechanical Engineers, American Society for Testing Materials, American Water Works Association, and the Ohio State University), 420 Lexington Avenue, New York, N. Y.
Priming and foaming of boiler waters.

National Electric Light Association (in cooperation with the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Water Works Association and the University of Michigan), 420 Lexington Avenue, New York, N. Y.
Development of standard methods for water analysis.

National Tube Co., Research Laboratory (in cooperation with the National District Heating Association), 4910 Forbes Street, Pittsburgh, Pa.
Effect of impure waters on water supply, and steam and hot-water piping.

North Dakota State Water Geologist, Howard E. Simpson, University Station, Grand Forks, N. Dak.
Methods of prospecting for city and industrial ground-water supplies.

Ohio State University, Columbus, Ohio.
Study of priming and foaming in boiler-feed water.

Ohio State University (in cooperation with the American Boiler Manufacturers Association, the American Railway Engineering Association, the American Society of Mechanical Engineers, the American Society for Testing Materials, the American Water Works Association and the National Electric Light Association), Columbus, Ohio.
Priming and foaming of boiler waters.

Oregon State Agricultural College, Department of Mechanical Engineering, Corvallis, Oreg.
Introduction into boilers of make-up steam instead of make-up water.

Pacific Coast Coal Co., Seattle, Wash.
Clarification of water from coal washeries.

University of Rochester, Institute of Applied Optics, Rochester, N. Y.
Radioactive content of spring waters in the neighborhood of Rochester.

The Trees Oil Co., Winfield Kans.
Analysis of oil-field waters.

United States Geological Survey, Washington, D.C.
Improvement of methods in drilling, casing, and screening water-supply wells.
Methods of recovery of ground water.
Water-yielding capacity of water-bearing beds in relation to method of recovery and to utilization.
Stratigraphy, geologic structure, and areal distribution of water-bearing beds.
Mode of occurrence, source, total quantity, and quantity of water which can be recovered economically.
Relation between chemical character of ground water and geologic occurrence.
Physical character of water-bearing materials in relation to recharge, discharge, and recovery of ground water, including laboratory determination of mechanical composition, porosity, permeability, and specific yield (quantity of water not absorbed on surfaces of grains).
Development of methods of determining permeability and specific yield of undisturbed materials in the field.
Identification of oil-field waters.

XIV. Safety, Health, and Miscellaneous

Aluminum Company of America, Aluminum Research Laboratories, Box 77, New Kensington, Pa.
Miscellaneous uses for bauxite and alumina.

American Chemical Products Co., 7 Litchfield Street, Rochester, N. Y.
Use of complex acid and salt compounds of tungsten and molybdenum in heavy solutions for mechanical separation of minerals.
The development of uses for osmium and osmic acid.

Anaconda Lead Products Co., 151st and McCook Avenues, East Chicago, Ind.
Lead compounds for insecticide purposes.

The Deister Concentrator Co., 901 Glasgow Avenue, Fort Wayne, Ind.
Separation and recovery of mica and kaolin.

General Engineering Co., Salt Lake City, Utah; 50 Broad Street, New York, N.Y.
Investigating the treatment of fluorspar ores from Texas.

Harvard University, The Harvard Engineering School, 112 Pierce Hall, Cambridge, Mass.; and The Harvard School of Public Health, 55 Van Dyke Street, Boston, Mass.
Control of the dust hazard in the granite industry.

Johns-Manville Corporation, Manville, N. J.
The processing of diatomaceous silica and the use of products made therefrom for abrasives and miscellaneous uses.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Utilization of various nonmetallic minerals, such as talcs, in sculpture.

University of Maryland, Agricultural Experiment Station, College Park, Md.
Phosphates, potash, sulphur, lime, boron, and other chemicals as plant foods.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Silicate fellowship.
Slag fellowship.

Metropolitan Life Insurance Co., Policyholders Service Bureau, 1 Madison Avenue, New York, N. Y.
Investigation of effects of inhalation of asbestos-dust.

Minerals Separation North American Corporation, 11 Broadway, New York, N. Y.: 220 Battery Street, San Francisco, Calif.
Flotation treatment of nonmetallic ores.

Mississippi Valley Research Laboratory, 660 South 18th Street, St. Louis, Mo.
Development of new uses of basalt.

Monmouth College, Department of Physics and Geology, Monmouth, Ill.
Extraction of finely divided colloidal silica from clays.
Extraction of metallurgical alumina from clays.

National Safety Council (in cooperation with the United States Public Health Service), 108 East Ohio Street, Chicago, Ill.
Efficiency of ventilating devices in certain dusty trades, such as sand blasting.

National Slag Association, 937 Leader Building, Cleveland, Ohio.
Physical and chemical properties of slags.
Development of new uses for slag.
Development and standardization of test methods for slag and its products.

University of New Hampshire, Department of Geology, Durham, N. H.
Garnet deposits of Wilmot and Danbury, N. H.

Norton Co., Worcester, Mass.
Electric-furnace abrasives.

Ost Laboratories, 6921 Natural Bridge Road, St. Louis, Mo.
Improvement of light sensitive selenium cells.

Pennsylvania Salt Manufacturing Co., Widener Building, Philadelphia, Pa.
Purification of cryolite by mechanical methods.
Purification of bauxite by mechanical methods.

Foster D. Snell, Consulting Chemist, 130 Clinton Street, Brooklyn, N. Y.
Suspension of suitable glass-insoluble abrasives in molten glass in the manufacture of abrasive glass.

Spencer Lens Co., 19 Doat Street, Buffalo, N. Y.
Location of source of supply for fluorite and calcite of good optical grade.

Swann Research (Inc.), Anniston, Ala.
Aluminous abrasive production.

University of Tennessee, Agricultural Experiment Station, Knoxville, Tenn.
Testing fluosilicates and the manner of their action.

United States Bureau of Mines, Nonmetallic Minerals Experiment Station (in cooperation with Rutgers University), New Brunswick, N. J.
Utilization of uncommon nonmetallic minerals in metallurgical processes.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Physiological effects of dusts.

United States Bureau of Standards, Washington, D.C.
Development and improvement of methods for the chemical analysis of dolomite, limestone, feldspars, fluorspar, glass sand, phosphate rock, bauxite, and chromite.

United States Geological Survey, Washington, D.C.
Occurrence, geologic relations, distribution, genesis, and mineralogy of lithium.

United States Public Health Service, Office of Industrial Hygiene and Sanitation, 16 Seventh Street, S.W., Washington, D.C.
Health of workers exposed to siliceous dust, such as those in the granite industry.
Efficiency of ventilating devices in certain dusty trades, such as the granite industry.

United States Public Health Service, Office of Industrial Hygiene and Sanitation (in cooperation with the National Safety Council), 16 Seventh Street, S.W., Washington, D.C.
Efficiency of ventilating devices in certain dusty trades such as sand blasting.

R. T. Vanderbilt Co. (Inc.), 230 Park Avenue, New York, N. Y.; Laboratory, 33 Winfield Street, East Norwalk, Conn.
Use of selenium in rubber.
Use of tellurium in rubber.

Virginia Agricultural Experiment Station, Blacksburg, Va.
Preparation of calcium sulphide for fungicide purposes from anhydrous calcium sulphate mined in Virginia.

Wittenberg College, Department of Chemistry, Springfield, Ohio.
Preparation of basic (dolomitic lime) digestants for straw utilized in the manufacture of straw paper.

D. METALLIC ORES AND PRODUCTS

I. Origin, Occurrence, Prospecting, Mining and Economics

John Simon Guggenheim Memorial Foundation, 551 Fifth Avenue, New York, N. Y.
Deposition of ore minerals from hot aqueous solutions at high pressures.

Harvard University, Cambridge, Mass.
Geological studies of the gold ores of the Homestake Mine, Lead, S. Dak.

Harvard University, Harvard Engineering School, Department of Mining Engineering, Rotch Building, Cambridge, Mass.
The effect of rock structure, permeability and composition on enrichment of ore deposits and their persistence in depth, especially at the following mines: Homestake, S. Dak.; Hollinger, Ont.; Hercules, Id.; San Luis Properties, Mexico; Morro Velho, Brazil; Cerro de Pasco Properties, Peru.

Michigan College of Mining and Technology, Houghton, Mich.
The stratigraphy of the Negannee formation of the Marquette District
Investigation of radio-field strengths above and below the earth's surface in the copper country of Michigan.

Geological Survey of Minnesota, University of Minnesota, Minneapolis, Minn.
Origin of the iron ores of Minnesota.

University of Minnesota, Minneapolis, Minn.
Zoning of metalliferous deposits.

Montana State School of Mines, State Bureau of Mines and Geology, Butte, Mont.
Geology and ore deposits of Bannack and Argenta.

State University of Montana, Department of Geology, Missoula, Mont.
Occurrence of chromite, molybdenite, and other minerals in Montana.

University of Rochester, Rochester, N. Y.
Economic geology of the Opemiska Region, Canada, and of the Mosquito Range, Colo.
Economic effects of the discovery and production of gold in South Africa.

St. Edward's University, Austin, Tex.
The relation of ultrabasic igneous rocks to other rocks; their rare mineral content (chromium ores, corundum, platinum group metals, and others), and their alteration to serpentine, asbestos, talc, and steatite.

United States Geological Survey, Washington, D. C.
Geologic relations, genesis, distribution, character, quantity available, and to a certain extent the economic features of mineral deposits.

Wabash College, Department of Chemistry, Crawfordsville, Ind.
Investigation of the alleged occurrence of colloidal noble metals in certain sedimentary rocks.

II. Beneficiation

University of Alabama, School of Chemistry, Metallurgy and Ceramics, University, Ala.
Removal of phosphorous from Alabama red ores before reaching the furnace.

University of Alabama (in cooperation with the United States Bureau of Mines), University, Ala.
Gravity concentration of the high-lime, red iron ores of the Chattanooga district.

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.
Iron-ore concentration.

Aluminum Co. of America, Aluminum Research Laboratory, Box 77, New Kensington, Pa.
Milling and beneficiation of bauxite.

American Cyanamid Co., 535 Fifth Avenue, New York, N. Y.
Use of cyanide in the selective flotation of base-metal ores.
Flotation tests on silver, gold, lead, copper, and zinc minerals and native copper.

Bagdad Copper Corporation, Hillside, Ariz.
Flotation of gold ores.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Beneficiation of lean iron ores.

Bucknell University, Lewisburg, Pa.
The mechanical concentration of ferberite (iron tungstate).

Case School of Applied Science, University Circle, Cleveland, Ohio.
Beneficiation of one of the Lake Superior iron ores.

Cerro de Pasco Copper Corporation, 44 Wall Street, New York, N. Y.
Concentration of complex lead-zinc-silver ores.

The Deister Concentrator Co., 901 Glasgow Avenue, Fort Wayne, Ind.
Recovery of metals from foundry residue and other waste materials.

The Dorr Co., 247 Park Avenue, New York, N. Y.
The concentration of iron ore by flotation.

Ford Motor Co., Dearborn, Mich.
Beneficiation of low-grade specular iron ore.

General Electric Vapor Lamp Co., 410 Eighth Street, Hoboken, N. J.
The use of ultra-violet light to produce fluorescence and phosphorescence in minerals as an indicator of the degree of separation effected during beneficiation.

Harvard University, Cambridge, Mass.
Factors affecting the separation of lead and zinc sulphides from complex lead-zinc ores.

University of Kentucky, Department of Mining and Metallurgy, Lexington, Ky.
Separation by flotation of lead and zinc sulphides from barytes in typical Kentucky ores of such type.

Koppers-Rheolaveur Co., 1150 Koppers Building, Pittsburgh, Pa.
Float-and-sink tests with heavy liquids on various types of iron ore from the Mesabi and other ranges in the Lake Superior district.
The application of Rheolaveur concentration principles to the beneficiation of iron ores.
Float-and-sink tests on lead and zinc ores, particularly from the Tri-State district.
The application of Rheolaveur principles of concentration to the ores of the Tri-State district.

Michigan College of Mining and Technology, Houghton, Mich.
Recovery of greater percentages of metallic copper from rock and sands.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
The Sweet-Adams launder classifier.
Amygdaloidal tailing reclaimation.
Flotation of copper.
Reclamation of zinc chats.
Beneficiation of Michigan low-grade iron ores.
Beneficiation of high-sulphur iron ores.
Direct reduction and beneficiation of iron ores.
The Kloman specular iron beneficiation.
Beneficiation of iron ore in the Iron River and Crystal Falls districts.
Classification of Michigan iron ores.
Magnetic and electrostatic investigations.

Missouri School of Mines and Metallurgy (in cooperation with Tri-State Zinc and Lead Ore Producers Association), Rolla, Mo.
Balance between grinding and flotable mineral recovery of Tri-State zinc ores.

Missouri School of Mines and Metallurgy (in cooperation with the United States Bureau of Mines, Rolla, Mo.
Improvements in the milling of southeast Missouri lead ores.
Lead losses in flotation of ores from oxidized seams in southeast Missouri lead mines.
Improvement of milling practice in the Tri-State zinc district.
Development of alternating-current magnetic separators.
Beneficiation of complex sulphide ores of the Pecos Valley mine, Glorietta, N. Mex.
Sampling and beneficiation of manganese ores.
Concentration of Lake Superior iron ores.

Missouri State Mining Experiment Station, Missouri School of Mines and Metallurgy, Rolla, Mo.
Determining the minimum amount of sodium cyanide necessary to produce a maximum depressive effect on pyrite when concentrating a galena-pyrite ore by flotation.
Beneficiating an old lead-silver-zinc-pyrite ore dump with mine-run ore and concentrating the values by flotation.

Montana State School of Mines, State Bureau of Mines and Geology, Butte, Mont.
Critical microscopic investigation of Anaconda mill products.
The differential flotation of copper and zinc sulphides.
The differential flocculation of copper, nickel, and iron sulphides.
Selective flotation of galena from chalcocite.

National City Chemical Co., Box G, National City, Calif.
Wet concentrators for the separation of gold from clayey material and for the separation of gold from gravels heavy in black sands.

Oliver United Filters (Inc.), Federal Reserve Bank Building, San Francisco, Calif.
Dewatering of iron concentrates by filtration and drying during filtration.

Oregon State Agricultural College, School of Mines, Corvallis, Oreg.
Beneficiation of chrome-ore minerals of Oregon.

Oriental Consolidated Mining Co. (in cooperation with the United States Bureau of Mines), 15 William Street, New York, N. Y.
Recovery of gold from refractory pyrite or base-metal ores.

Rensselaer Polytechnic Institute, Troy, N. Y.
Improvements in the separation of iron and copper in nickel ores.

Stanford University, Stanford University, Calif.
The concentration of chromite.

Superior Zinc Corporation, Bristol, Pa.
Beneficiation of chlorine-bearing zinc materials to fit them for a wider market and at a better price.

Tennessee Copper Co., Copperhill, Tenn.
Flotation of manganese ores.

Tri-State Zinc and Lead Ore Producers Association (in cooperation with the Missouri School of Mines and Metallurgy), Box 95, Miami, Okla.
Balance between grinding and floatable mineral recovery of Tri-State zinc ores.

The Twining Laboratories, 2527 Fresno Street, Fresno, Calif.
Concentration of chromite.

United States Bureau of Mines, Intermountain Experiment Station (in cooperation with the University of Utah), Salt Lake City, Utah.
Flotation of jarosites.

United States Bureau of Mines, Mississippi Valley Experiment Station (in cooperation with the Missouri School of Mines and Metallurgy), Rolla, Mo.
Development of alternating-current magnetic separators.
Beneficiation of complex sulphide ores of the Pecos Valley mine, Glorietta, N. Mex.
Sampling and beneficiation of manganese ores.
Improvements in the milling of southeast Missouri lead ores.
Lead losses in flotation of ores from oxidized seams in southeast Missouri lead mines.
Improvement of milling practice in the Tri-State zinc district.
Concentration of Lake Superior iron ores.

United States Bureau of Mines, Rare and Precious Metals Experiment Station (in cooperation with the University of Nevada), Reno, Nevada.
Precious metal loss in present milling practice.

United States Bureau of Mines, Rare and Precious Metals Experiment Station (in cooperation with the Oriental Consolidated Mining Co.), Reno, Nev.
Recovery of gold from refractory pyrite or base-metal ores.

United States Bureau of Mines, Southern Experiment Station (in cooperation with the University of Alabama), Tuscaloosa, Ala.
Gravity concentration of the high-lime, red iron ores of the Chattanooga district.

Utah Copper Co., Garfield, Utah.
Crushing, screening, grinding, classifying, and separating minerals by flotation.
Developing flotation reagents.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research, Salt Lake City, Utah.
- Flotation of chalcopyrite.
- Flotation of carbonates and silicates of copper.
- Flotation of carbonates and sulphates of lead.
- Flotation of sphalerite.
- The separation of sphalerite from pyrite and pyrrhotite.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research (in cooperation with the United States Bureau of Mines), Salt Lake City, Utah.
- Flotation of jarosites.

University of Wisconsin, Department of Mining and Metallurgy, Madison, Wis.
- Flotation of the southwest Wisconsin zinc ores.

III. Methods of Analysis and Test

Aluminum Industries (Inc.), 2416-38 Beekman Street, Cincinnati, Ohio.
- Methods of analysis of aluminum alloys.

American Chain Co., (Inc.), Bridgeport, Conn.
- Nondestructive testing of steel.

American Foundrymen's Association (in cooperation with the United States Bureau of Standards), 222 West Adams Street, Chicago, Ill.
- Development of a method of measuring liquid shrinkage of cast metals.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and 13 manufacturers), 29 West 39th Street, New York, N. Y.
- Development of comparative high-temperature short-time tension tests.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
- Accelerated corrosion tests.
- Accelerated tests for protective coatings.
- Development of electrical and mechanical tests of heating and resistance alloys.
- Development of life test for durability of electrical-resistance wire at high temperatures.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and 13 manufacturers), 1315 Spruce Street, Philadelphia, Pa.
- Development of comparative high-temperature short-time tension tests.

American Society for Testing Materials (in cooperation with the Union Carbide and Carbon Corporation), 1315 Spruce Street, Philadelphia, Pa.
- Bend test for metals.

American Society for Testing Materials (in cooperation with the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Corrosion tests for galvanized materials.

University of Arizona (in cooperation with the United States Bureau of Mines), Tucson, Ariz.
The magnetic balance for determining magnetite.

Babcock & Wilcox Co., 85 Liberty Street, New York, N. Y.
Methods of testing welds.

Barber-Colman Co., Rockford, Ill.
Improvements in methods of measuring hardness.

Cadillac Motor Car Co., Detroit, Mich.
Method of measuring electroplated coatings.
Rapid method of quantitative analysis of structural metals and materials.

California Institute of Technology, Department of Mechanics, Pasadena, Calif.
Investigation to determine whether Shore scleroscope would show different rebounds for specimens under stress and specimens not under stress.

University of California, Department of Mining and Metallurgy, Berkeley, Calif.
Tests of and improvements upon the methods of assaying bismuth.

College of the City of Detroit, Department of Chemistry, 4841 Cass Avenue, Detroit, Mich.
Analysis of barium metals.

General Electric Co., Schenectady, N. Y.
Tests of metal arc welds.
Classification and physical tests for various types of welded-plate joints.

L. F. Grammes & Sons (Inc.), 350 Union Street, Allentown, Pa.
Etching ferrous and nonferrous metals.

University of Illinois, Urbana, Ill.
Study of the Ikeda (electrical resistance) short-time test for fatigue strength of metals.

Iowa State Highway Commission, Ames, Iowa.
Development of a wear test for metals.

Massachusetts Institute of Technology, Cambridge, Mass.
Examination of welds by the X-ray diffraction method.

Massachusetts Institute of Technology, Department of Mining and Metallurgy, 69 Massachusetts Avenue, Cambridge, Mass.
Structural examination of metals by means of the X-ray.
Analytical determination of platinum-group metals.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
X-ray examinations of castings.

University of Minnesota, School of Chemistry, Minneapolis, Minn.
Application of X-rays in the study of various metallurgical problems.

National Slag Association, 937 Leader Building, Cleveland, Ohio
Development and standardization of test methods for slag and its products.

University of Pittsburgh, School of Mines, Department of Metallurgy, Pittsburgh, Pa.
Scratch hardness testing of metals.

Public Service Electric & Gas Co., Newark, N. J.
Development of fatigue-testing machine for bolt material.

Rensselaer Polytechnic Institute, Troy, N. Y.
The analytical determination of cadmium in the presence of zinc.
Radiographic examination of castings and various structures.
Crystal analyses of alloys.

Sperry Development Co., Manhattan Bridge Plaza, Brooklyn, N. Y.
Nondestructive test of welds by electric-resistance method.

Stevens Institute of Technology, Hoboken, N. J.
Photomicrography of metals.

Union Carbide & Carbon Corporation, Research Laboratory, Thompson Avenue and Manley Street, Long Island City, N. Y.
Nondestructive testing of welds by means of the stethoscope and X-ray.

Union Carbide and Carbon Corporation, Research Laboratories (in cooperation with the American Society for Testing Materials), Long Island City, N. Y.
Bend test for metals.

United States Bureau of Mines, Intermountain Experiment Station (in cooperation with the University of Utah), Salt Lake City, Utah.
Development of microchemical methods by which the minerals of lead-silver may be identified.

United States Bureau of Mines, Southwest Experiment Station (in cooperation with the University of Arizona), Tucson, Ariz.
Chemical methods of mineralogical analysis of copper ores and products.
The magnetic balance for determining magnetite.

United States Bureau of Standards, Washington, D. C.
Metallographic polishing technique.
X-ray methods for determining the crystal structure of metals.
Development and improvement of methods for the chemical analysis of zinc and manganese ores, brasses, bronzes, bearing metals, light aluminum alloys, zinc-base die-casting alloys, iron ores, cast irons, steels, ferroalloys, and alloy steels.
Study of "A_2" in iron by the beta-ray spectrometer.
Pyrometry of ferrous metals.
Laboratory corrosion test methods for stainless steels.
The utility of the spark test for the rapid identification of steels.
Methods of analysis of silver plating.
Methods of analysis of the metals of the platinum group.
A quantitative method for the determination of corrosive elements in petroleum products and liquid fuels.

United States Bureau of Standards (in cooperation with the American Foundrymen's Association), Washington, D.C.
Development of a method of measuring liquid shrinkage of cast metals.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D. C.
Corrosion tests for galvanized materials.

United States Naval Research Laboratory, Bell, Md.
Use of gamma ray for examining welds.

United States Navy, Watertown Arsenal, Watertown, N. Y.
X-ray examination of welds.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
Electromagnetic analysis and testing.
Measurement of high temperatures.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research (in cooperation with the United States Bureau of Mines), Salt Lake City, Utah.
Development of microchemical methods by which the minerals of lead-silver may be identified.

Wappler Electric Co., (Inc.), 162 Harris Avenue, Long Island City, N. Y.
Methods and apparatus for X-ray study of metal powders, minerals, etc.

West Virginia State College, Institute, W. Va.
Identification of aluminum, manganese, tin, and zinc by the use of organic reagents.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
Weld testing by measurement of magnetic potentials.
Magnetic testing of butt welds.

IV. Properties: Thermal, Electrical, and Magnetic

AC Spark Plug Co., Flint, Mich.
Magnetic properties of ferrous alloys.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.
Coefficient of expansion of special steels.

Allis-Chalmers Manufacturing Co. (in cooperation with the University of Michigan), Milwaukee, Wis.
Creep-test analysis at elevated temperature on materials suitable for large stationary and rotating structures.
Intermittent creep tests of 500 pounds per square inch at 850° F. for 2,000 hours on forged and cast steels.

American Engineering Co., Philadelphia, Pa.
Effect of high-temperature preheated air on expansion of stoker parts.

American Hammered Piston Ring Co., Box 758, Baltimore, Md.
Improvement of structure of metals to give heat resistance and heat conductivity.

American Manganese Steel Co., 6600 Ridge Avenue, St. Louis, Mo.
Development of heat-resisting alloys of nickel and chromium.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials, Battelle Memorial Institute, and the Engineering Foundation), 29 West 39th Street, New York, N. Y.
Effect of temperature on the properties of metals.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and the Battelle Memorial Institute), 29 West 39th Street, New York, N. Y.
Creep of metals at elevated temperatures.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and the University of Illinois), 29 West 39th Street, New York, N. Y.
Fatigue tests on a low-carbon steel at high temperatures.
Effect of temperature upon the fatigue or endurance properties of metals.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and 13 manufacturers), 29 West 39th Street, New York, N. Y.
Comparative high-temperature short-time tension tests.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and various industrial laboratories), 29 West 39th Street, New York, N. Y.

Development of a test code for high-temperature tensile and creep tests.

High-temperature effects on mechanical properties and structural stability of cast, wrought, and stainless steel.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.

Development of electrical and mechanical tests of heating and resistance alloys.

Development of life test for durability of electrical-resistance wire at high temperatures.

Study of magnetic properties of steel and their correlations with other properties and with general performance.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers), 1315 Spruce Street, Philadelphia, Pa.

Effect of temperature on the properties of metals.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and the Battelle Memorial Institute), 1315 Spruce Street, Philadelphia, Pa.

Creep of metals at elevated temperatures.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and the University of Illinois), 1315 Spruce Street, Philadelphia, Pa.

Fatigue tests on a low-carbon steel at high temperatures.

Effect of temperature upon the fatigue or endurance properties of metals.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and 13 manufacturers), 1315 Spruce Street, Philadelphia, Pa.

Comparative high-temperature short-time tension tests.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and various industrial laboratories), 1315 Spruce Street, Philadelphia, Pa.

Development of a test code for high-temperature tensile and creep tests.

High-temperature effects on mechanical properties and structural stability of cast, wrought, and stainless steel.

University of Arizona (in cooperation with the United States Bureau of Mines), Tucson, Ariz.

The magnetic balance for determining magnetite.

Automatic Electric (Inc.), 1027 West Van Buren Street, Chicago, Ill.

Characteristics of electromagnetic iron and permanent magnet steels.

Babcock & Wilcox Co. (in cooperation with the Massachusetts Institute of Technology), 85 Liberty Street, New York, N. Y.
Flow of steel at high temperatures.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Comprehensive study of the properties of cast irons with a view to developing iron of superior quality, especially with reference to properties at elevated temperatures.
Thermal properties of metals.
Low-temperature properties of aircraft materials, including fatigue, impact, tensile properties, etc.

Battelle Memorial Institute (in cooperation with the American Society of Mechanical Engineers), 505 King Avenue, Columbus, Ohio.
Effect of temperature on the properties of metals.

Battelle Memorial Institute (in cooperation with the American Society for Testing Materials and the American Society of Mechanical Engineers), 505 King Avenue, Columbus, Ohio.
Creep of metals at elevated temperatures.

The Calorizing Co., 400 Hill Street, Wilkinsburg, Pa.
Development of alloys for resistance to corrosion at elevated temperatures and high strength of materials at elevated temperatures.

Carnegie Institute of Technology, Bureau of Metallurgical Research, Schenley Park, Pittsburgh, Pa.
Recrystallization of metals after cold-working and heating.
Thermal characteristics of steels.

Cochrane Corporation, 17th Street Below Allegheny Avenue, Philadelphia, Pa.
Cast iron to resist temperatures up to 750° F.

Crane Co. Laboratory, 836 South Michigan Avenue, Chicago, Ill.
Long-time tension tests of steels at elevated temperatures.

Detroit Edison Co. (in cooperation with the University of Michigan), 2000 Second Avenue, Detroit, Mich.
Metals at elevated temperatures for use in power service.

The Engineering Foundation (in cooperation with the American Society of Mechanical Engineers), 29 West 39th Street, New York, N. Y.
Effect of temperature on the properties of metals.

General Electric Co., 1 River Road, Schenectady, N. Y.
Magnetic properties of Ni-Fe alloys.

General Electric Company, Research Laboratory, Schenectady, N. Y.
The high-temperature properties of steels.
Characteristics of various steels under torsion and at elevated temperatures.

Harvard University, Cambridge, Mass.
- Steel at elevated temperatures.
- X-ray investigation of the stability of austenitic steels at low and high temperature.

University of Illinois, Urbana, Ill.
- Fatigue tests of steel at elevated temperatures.

University of Illinois (in cooperation with the American Society of Mechanical Engineers and the American Society for Testing Materials), Urbana, Ill.
- Fatigue tests on a low-carbon steel at high temperatures.
- Effect of temperature upon the fatigue or endurance properties of metals.

The Lunkenheimer Co., Cincinnati, Ohio.
- Study of properties of metals at elevated temperatures.

Massachusetts Institute of Technology, Department of Mining and Metallurgy, 69 Massachusetts Avenue, Cambridge, Mass.
- Magnetic properties of iron-carbon alloys as a means of studying critical changes.
- Heat-resisting steels.

Massachusetts Institute of Technology, Department of Physics, Cambridge, Mass.
- Thermal conductivity of metals at high temperatures.

Massachusetts Institute of Technology, Department of Physics, in cooperation with the Babcock & Wilcox Co.), Cambridge, Mass.
- Flow of steel at high temperatures.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
- Corelations of copper conductivity.

University of Michigan, Ann Arbor, Mich.
- Strength of ductile materials subjected to shear at elevated temperatures.
- Physical properties of American Society for Testing Materials grades A and B seamless steel boiler pipes at 850° F.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
- Effect of temperature on tensile strength of lead.
- Alloys at elevated temperatures.
- Thermal conductivity of certain alloys.
- Thermal expansion of brass.
- Thermal expansion of steel.
- Thermal conductivity of steel.
- Study of the strength and related properties of ferrous and nonferrous metals at elevated temperatures.

University of Michigan (in cooperation with Allis-Chalmers Manufacturing Co.), Ann Arbor, Mich.
- Creep-test analysis at elevated temperature on materials suitable for large stationary and rotating structures.
- Intermittent creep tests of 500 pounds per square inch at 850° F. for 2,000 hours on forged and cast steels.

University of Michigan (in cooperation with the Detroit Edison Co.), Ann Arbor, Mich.
- Metals at elevated temperatures for use in power service.

The Midvale Co., Nicetown, Philadelphia, Pa.
- Magnetic properties of steel.
- Effect of temperature on physical properties of steel.
- Properties of metals at high temperatures.

Montana State School of Mines, Butte, Mont.
- The electrical conductivity of cold-drawn and annealed metals and alloys.

Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn, N. Y.
- Effect of arsenic on some physical and electrical properties of iron.
- Effect of original grain size of low-carbon steel on tensile properties at elevated temperatures.
- Effect of frequency on the fatigue limit of steel by rise in temperature and increase in electrical resistance.

Polytechnic Institute of Brooklyn, Department of Civil Engineering, 99 Livingston Street, Brooklyn, N. Y.
- Investigation of the torsional strength of metals at high temperature.

Rensselaer Polytechnic Institute, Troy, N. Y.
- Thermal conductivity of the ores of iron-nickel alloys.
- Electrical resistances and temperature coefficients of metals and alloys.
- Thermal conductivity of metals and alloys by a dynamic method.
- Investigation of the torsional strength of the metals at high temperature.
- Electrical conductance, microstructure, and expansion of duriron alloys.
- Thermal e.m.f. of alloys.
- Magnetic properties of iron-chromium alloys.

Russell Electric Co., 340 West Huron Street, Chicago, Ill.
- Chemical inertness, thermal conductivity, dielectric strength, and insulation resistance at elevated temperatures.

United States Bureau of Mines, Southwest Experiment Station (in cooperation with the University of Arizona), Tucson, Ariz.
- The magnetic balance for determining magnetite.

United States Bureau of Standards, Washington, D. C.
Effect of temperature on properties of metals.
Thermal conductivity of metals.
Compression properties and impact resistance of metals at high temperatures.
Determination of melting or freezing points of pure metals.
Properties of building materials at high temperatures.
Study of heat-resisting alloys.
The compressive strength and deformation of structural steel and cast-iron shapes at high temperatures.
Flow characteristics of iron-nickel and chromium alloys and steels under load at elevated temperatures.
Fire tests of welded-steel floor construction.
Melting point of ferrous metals, including iron.
Thermal properties of pure thorium.
Primary standard of light and the melting point of platinum.
Thermoelectric properties of pure metals.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
Measurement of high temperatures.
Rate of transformation of steels at various temperatures.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
Thermoelectric properties of silicon - copper alloys.
Thermoelectric properties of beryllium.

Yale University, Sloane Physics Laboratory, New Haven, Conn.
Magnetic properties of manganese as affected by purity and crystal structure.
Magnetic lag in iron (not due to eddy currents).

V. Properties: Corrosion, Erosion, and Embrittlement

General

American Hammered Piston Ring Co., Box 758, Baltimore, Md.
Improvement of structure of metals to give wear resistance and corrosion resistance.

American Manganese Steel Co., 6600 Ridge Avenue, St. Louis, Mo.
Corrosion-resisting alloys of nickel and chromium.
Resistance of 12 Ni-Cr alloys to acids of different concentrations at different temperatures.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Corrosion of crude-oil storage tanks.

American Society of Mechanical Engineers (in cooperation with Brooklyn Edison Co.), 29 West 39th Street, New York, N. Y.
Effect of air and of turbulence on condenser-tube deterioration.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
Accelerated corrosion tests.
Atmospheric-corrosion tests of metallic-coated products.
Atmospheric-corrosion tests of uncoated sheets.
Total immersion tests on uncoated sheets.
Metal culvert corrosion tests.

American Society for Testing Materials (in cooperation with Battelle Memorial Institute), 1315 Spruce Street, Philadelphia, Pa.
Embrittlement of hot-dipped galvanized structural steel.

American Society for Testing Materials (in cooperation with the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Corrosion tests of galvanized materials.
Relative life of various screen wire cloths.

Battelle Memorial Institute (in cooperation with the American Society for Testing Materials), 505 King Avenue, Columbus, Ohio.
Embrittlement of hot-dipped galvanized structural steel.

S. F. Bowser & Co. (Inc.), Fort Wayne, Ind.
Determining metals best suited for handling and storage of various liquids such as all petroleum products, chemicals, and food products.

Brooklyn Edison Co. (Inc.), 380 Pearl Street, Brooklyn, N. Y.
Causes and prevention of condenser-tube corrosion and influence on heat transfer.

Brooklyn Edison Co. (Inc.), (in cooperation with the American Society of Mechanical Engineers), 380 Pearl Street, Brooklyn, N. Y.
Effect of air and of turbulence on condenser-tube deterioration.

Cadillac Motor Car Co., Detroit, Mich.
Development of methods and materials for quickly and economically producing nitrided parts to resist wear and corrosion.

California Agricultural Experiment Station, College of Agriculture, Davis, Calif.
Bearing wear as affected by the character and condition of the lubricant, especially crank case-oil filters and their effect on engine wear.

The Calorizing Co., 400 Hill Avenue, Wilkinsburg, Pa.
Application of aluminum metal to surface of other metals as steel, copper, and alloys for protection of base metal against corrosion at elevated temperatures.
Development of alloys for resistance to corrosion at elevated temperatures, and high strength of materials at elevated temperatures.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
A study of metals to withstand various services, such as attack by refrigerants in the presence of water, by the condensate from manufactured gas, by steam condensate and by a wide variety of vapors and liquids found in the atmosphere in processes requiring air conditioning. This includes extended corrosion tests, scale observations and physical tests.
Rust inhibitors and neutralizers for addition to water.

Cast Iron Pipe Research Association (in cooperation with the United States Bureau of Standards), 566 Peoples Gas Building, Chicago, Ill.
Causes of soil corrosion of metal pipe.

Dearborn Chemical Co., 1029 West 35th Street, Chicago, Ill.
Prevention and control of corrosion.

Duquesne Light Co., Pittsburgh, Pa.
Turbine-blade erosion.
Condenser-tube corrosion.

The Duriron Co. (Inc.), Dayton, Ohio.
Use of acid-resisting materials.

Humble Oil & Refining Co., Houston, Tex.
General study of corrosion, not only of tankage where the corrosion is caused mainly by hydrogen sulphide, but also of the equipment in which the processing of the crude is carried out.
Methods of prevention of corrosion of crude tankage due to the presence of hydrogen sulphide and other sulphur compounds.

Iowa State Highway Commission, Ames, Iowa.
Development of a wear test for metals.

Johns Hopkins University, Baltimore, Md.
The corrosion of pipe by hot water.

Robert W. Hunt Co., 166 West Van Buren Street, Chicago, Ill.
Corrosion of pipe.

Hupp Motor Car Corporation, Detroit, Mich.
Corrosion of cooling systems.

Jackson Engineering Corporation, 11 East Fifth Avenue, Tulsa, Okla.
Selection of metals to resist corrosion of hot hydrogen sulphide solutions of triethanolamine and water.

Lehigh University, Department of Metallurgical Engineering, Bethlehem, Pa.
Protective values of cadmium and zinc platings against corrosion-fatigue of steel.

The Lunkenheimer Co., Cincinnati, Ohio.
Corrosion in industrial applications.
Development of new alloys to meet conditions of corrosion, wear resistance, and strength in the most economical manner.

McCord Radiator Manufacturing Co., Detroit, Mich.
Development of most economical metal and one most resistant to electrolysis or corrosion.

Massachusetts Institute of Technology, Department of Mining and Metallurgy, 69 Massachusetts Avenue, Cambridge, Mass.
Wear resistance of metals.

Metals Coating Co. of America, 497 North 3d Street, Philadelphia, Pa.
Corrosion protection by sprayed molten metal coatings.

University of Michigan, Ann Arbor, Mich.
Studies of caustic embrittlement failures.

The Midvale Co., Nicetown, Philadelphia, Pa.
Wear resistance.
Resistance to corrosion and oxidation.

Montana State College of Agriculture and Mechanic Arts, Engineering Experiment Station, Bozeman, Mont.
The corrosion of automobile engines by sulphur compounds in gasoline.

New York Edison System, 4 Irving Place, New York, N. Y.
Condenser-tube deterioration.
Experiments to increase life of condenser tubes at Hell Gate station.

Oklahoma Agricultural and Mechanical College, Stillwater, Okla.
Pipe corrosion.

Pacific Gas & Electric Co., 245 Market Street, San Francisco, Calif.
Electrolysis prevention by means of an imposed countercurrent.

Pennsylvania Water & Power Co., Lexington Street Building, Baltimore, Md.
Study of metals to resist corrosive action of water for submerged parts of water turbine.

Polytechnic Institute of Brooklyn, Department of Mechanical Engineering, Brooklyn, N. Y.
Corrosion during heat treatment of metals.

Public Service Electric & Gas Co., Newark, N. J.
Caustic-embrittlement studies in connection with plant equipment.
Study on corrosion of condenser tubes due to air liberated from circulating water.
Studies of electrolytic corrosion.

Rensselaer Polytechnic Institute, Troy, N. Y.
    Corrosion of alloys.

Robertshaw Thermostat Co., Youngwood, Pa.
    Corrosive action of gas and heat on metals.

Henry Souther Engineering Co., Hartford, Conn.
    Research on corrosion-resistant material for valve bodies and trim.

United Gas Improvement Co., 3101 Passyunk Avenue, Philadelphia, Pa.
    General research on condenser tubes.
    Corrosion of welded joints.

United States Bureau of Mines, Petroleum Experiment Station, Bartlesville, Okla.
    Study of tank corrosion.

United States Bureau of Standards, Washington, D. C.
    Aeration factor in submerged corrosion.
    A quantitative method for the determination of corrosive elements in petroleum products and liquid fuels.
    The relation of corrosion and fatigue of metals.
    Fundamental principles of the wear abrasion of materials.
    Resistance of metals suitable for dies to the abrasive action of plastic clay.

United States Bureau of Standards (in cooperation with the American Electro-Platers Society), Washington, D. C.
    Corrosion tests of plated deposits on ferrous metals.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D. C.
    Corrosion tests for galvanized materials.
    Exposure tests of screen wire cloth.

United States Bureau of Standards (in cooperation with the Cast Iron Pipe Research Association), Washington, D. C.
    Causes of soil corrosion of metal pipe.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
    Erosion of turbine-blading materials by steam.
    Behavior of condenser tubes under simulated service conditions.
    Effect of stress, time, and number of cycles in causing penetration of metal under corrosion.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
    Investigations on corrosion.

Westinghouse Electric & Manufacturing Co., South Philadelphia Works, South Philadelphia, Pa.
    Determination of resistance of various materials to erosion.

White Eagle Oil Corporation, 1400 Federal Reserve Bank Building, Kansas City, Mo.
Corrosion and erosion in refining equipment.

Ferrous

Allegheny Steel Co. (in cooperation with the American Society for Testing Materials), Brackenridge, Pa.
Corrosion tests of stainless steels.

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.
Value of gray cast iron under conditions of sliding friction.
Wearing test of chilled cast iron under conditions of impact and abrasion.

American Chain Co. (Inc.), Bridgeport, Conn.
Resistance to corrosion and abrasion of carbon and alloy steels.

American Electro-Platers Society (in cooperation with the United States Bureau of Standards), 434 South Wabash Avenue, Chicago, Ill.
Corrosion tests of plated deposits on ferrous metals.

American Society for Testing Materials (in cooperation with the Battelle Memorial Institute and the Utilities Research Commission, Incorporated), 1315 Spruce Street, Philadelphia, Pa.
Causes of embrittlement in steel.

American Society for Testing Materials (in cooperation with 16 industrial and governmental laboratories), 1315 Spruce Street, Philadelphia, Pa.
Corrosion tests of stainless steels.

Armour Institute of Technology, Department of Chemical Engineering, 3300 Federal Street, Chicago, Ill.
Causes of boiler-tube corrosion on the gas side, and methods of preventing the same.

Battelle Memorial Institute (in cooperation with the American Society for Testing Materials and the Utilities Research Commission, Incorporated), 505 King Avenue, Columbus, Ohio.
Causes of embrittlement in steel.

Bell Telephone Laboratories (in cooperation with the American Society for Testing Materials), 463 West Street, New York, N. Y.
Corrosion tests of stainless steels.

Bethlehem Steel Co. (in cooperation with the American Society for Testing Materials), Bethlehem, Pa.
Corrosion tests of stainless steels.

A. M. Byers Co., Pittsburgh, Pa.
Corrosion of steel.

Cadillac Motor Car Co., Detroit, Mich.
Development of methods and materials for quickly and economically producing nitrided parts to resist wear and corrosion.

Carpenter Steel Co. (in cooperation with the American Society for Testing Materials), Reading, Pa.
Corrosion tests of stainless steels.

Chicago, Milwaukee, St. Paul & Pacific Railroad Co., Union Station Building, Chicago, Ill.
Reduction of pitting by feet-water heating.

Cochrane Corporation, 17th Street below Allegheny Avenue, Philadelphia, Pa.
Noncorrosive and non-oxidizing iron.

Crucible Steel Co. (in cooperation with the American Society for Testing Materials), Harrison, N. J.
Corrosion tests of stainless steels.

Detroit Edison Co., 2000 Second Avenue, Detroit, Mich.
Investigation of boiler No. 28 Delray Power plant for evidence of caustic embrittlement.

Detroit Steel Products Co., West Grand Boulevard, Detroit, Mich.
Protection against corrosion of steel.

E. I. Du Pont de Nemours & Co. (in cooperation with the American Society for Testing Materials), Wilmington, Del.
Corrosion tests of stainless steels.

Electrolux Servel Corporation, 408 East 111th Street, New York, N. Y.
Steel corrosion by ammonia in refrigeration.

A. Finkl & Sons Co., 1326 Cortland Street, Chicago, Ill.
Production of a ferrous metal or alloy which will better withstand abrasion, fire cracking, and impact stresses and be highly machinable.

Firestone Steel Products Co., Akron, Ohio.
Corrosion of steel.

Frigidaire Corporation (in cooperation with the American Society for Testing Materials), Dayton, Ohio.
Corrosion tests of stainless steels.

General Electric Co., Research Laboratories, Schenectady, N. Y.
Endurance properties of steel in steam.
The corrosion fatigue of steels in steam.

General Electric Co. (in cooperation with the American Society for Testing Materials), Schenectady, N. Y.
Corrosion tests of stainless steels.

General Motors Corporation (in cooperation with the American Society for Testing Materials), Detroit, Mich.
Corrosion tests of stainless steels.

Hall Laboratories (Inc.), Pittsburgh, Pa.
Investigation of corrosion in district steam-heating mains.
Water conditioning and prevention of corrosion-scale formation and boiler-metal cracking in steam-generating stations.

Harvard University, Cambridge, Mass.
Corrosion of iron water pipes.
The occurrence of oxygen in iron and steel and its influence on hot brittleness.

University of Illinois, Urbana, Ill.
Control of boiler-water treatment to prevent embrittlement.

University of Illinois, Department of Industrial Chemistry, Urbana, Ill.
Prevention of corrosion by flue gas.

International Harvester Co.; 606 South Michigan Avenue, Chicago, Ill.
Corrosion-resistant ferrous metals.
Erosion-resistant materials and their treatments.

The International Nickel Co. (Inc.), Development and Research Department, 67 Wall Street, New York, N. Y.
Corrosion-resisting ferrous alloys.

Johns Hopkins University, Baltimore, Md.
Corrosion of wrought iron and steel pipe under service conditions.

Lebanon Steel Foundry, Lebanon, Pa.
Corrosion, erosion, and heat-resistant cast steels for all phases of oil distillation and cracking.
Corrosion-resisting cast steels for service exposed to mine water.

Lion Oil Refining Co., El Dorado, Ark.
Prevention of corrosion in condenser tubes of pipe still.

Midvale Steel Co. (in cooperation with the American Society for Testing Materials), Philadelphia, Pa.
Corrosion tests of stainless steels.

Minneapolis General Electric Co., Minneapolis, Minn.
Study of factors involved in development of caustic embrittlement of boiler steel.

New York Edison System, 4 Irving Place, New York, N. Y.
Study of corrosion resistance for chromium-steel alloy used in switch mechanisms.

Parker Rust Proof Co., 2177 East Milwaukee Avenue, Detroit, Mich.
Processes for the treatment of iron and steel to prevent corrosion.

Republic Steel Co. (in cooperation with the American Society for Testing Materials), Massillon, Ohio.
Corrosion tests of stainless steels.

Rose Polytechnic Institute, Terre Haute, Ind.
Corrosion in high-pressure (150 lb.) gas lines.

Taylor Wharton Iron & Steel Co., High Bridge, N. J.
Corrosion of rustproof steel castings.

Tubize-Chatillon Corporation, Rome, Ga.
Resistance of iron alloys to corrosion by acetic acid and mixtures containing salts.

Union Carbide & Carbon Corporation, Research Laboratory (in cooperation with the American Society for Testing Materials), Long Island City, N. Y.
Corrosion tests of stainless steels.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D. C.
Corrosion tests of stainless steels.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
Corrosion tests of stainless steels.
The effects of variable amounts of oxygen in water on the corrosion-fatigue limit of boiler steel.

United States Naval Research Laboratory, Bureau of Engineering (in cooperation with the American Society for Testing Materials), Anacostia, D. C.
Corrosion tests of stainless steels.

United States Navy, Bureau of Construction and Repair (in cooperation with the American Society for Testing Materials), Washington, D. C.
Corrosion tests of stainless steels.

Utilities Research Commission (Inc.), (in cooperation with the American Society for Testing Materials and the Battelle Memorial Institute), 72 West Adams Street, Chicago, Ill.
Causes of embrittlement in steel.

Walworth Alabama Company, Attalla, Ala.
Corrosion of cast iron and alloyed cast iron.

Walworth Co., Statler Building, Boston, Mass.
Ferrous alloys for high pressures and temperatures and resistant to chemicals.

Westinghouse Electric & Manufacturing Co. (in cooperation with the American Society for Testing Materials), East Pittsburgh, Pa.
Corrosion tests of stainless steels.

West Virginia State Highway Department, Charleston, W. Va.
Accelerated corrosion tests on culvert pipe of concrete, cast-iron, and corrugated-iron pipe with different coatings.

Worcester Polytechnic Institute, Department of Chemistry, Worcester, Mass.
Corrosion of chrome-nickel steel.

Nonferrous

Aluminum Co. of America (in cooperation with the American Society for Testing Materials), New Kensington, Pa.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

The American Brass Co., Waterbury, Conn.
The relative corrosion of copper, copper alloys, and other metals.

American Brass Co. (in cooperation with the American Society for Testing Materials), Waterbury, Conn.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3 and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc base alloys with exposure-test data.

American Can Co., Research Department, 11th Avenue and St. Charles Road, Maywood, Ill.
The corrosion of tin plate by food products.

American Chain Co. (Inc.), Bridgeport, Conn.
Resistance to corrosion and erosion of nonferrous alloys.

American Manganese Bronze Co. (in cooperation with the American Society for Testing Materials), Holmesburg, Philadelphia, Pa.
Corrosion of nonferrous metals and alloys in liquids.

American Society for Testing Materials (in cooperation with the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Exposure tests on nonferrous metals and alloys.

American Society for Testing Materials (in cooperation with 14 university, industrial and governmental laboratories), 1315 Spruce Street, Philadelphia, Pa.
Atmospheric corrosion of nonferrous metals and alloys.
Corrosion of nonferrous metals and alloys in liquids.
Galvanic and electrolytic corrosion of nonferrous metals and alloys.

American Society for Testing Materials (in cooperation with 16 industrial and governmental laboratories), 1315 Spruce Street, Philadelphia, Pa.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

Bell Telephone Laboratories (Inc.) (in cooperation with the American Society for Testing Materials), New York, N. Y.
Galvanic and electrolytic corrosion of nonferrous metals and alloys.
Atmospheric corrosion of nonferrous metals and alloys.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

Bond Manufacturing Corporation, Monroe and 5th Street, Wilmington, Del.
Corrosion problems of tin and lead collapsible tubes.

Bridgeport Brass Co. (in cooperation with the American Society for Testing Materials), Bridgeport, Conn.
Corrosion of nonferrous metals and alloys in liquids.

Bunting Brass & Bronze Co. (in cooperation with the United States Bureau of Standards), Toledo, Ohio.
Dry wear testing of bronze alloys.
Lubricated wear testing of bronze alloys.

University of California (in cooperation with the American Society for Testing Materials), Berkeley, Calif.
  Atmospheric corrosion of nonferrous metals and alloys.

Central Arizona Light & Power Co. (in cooperation with the American Society for Testing Materials), Phoenix, Ariz.
  Atmospheric corrosion of nonferrous metals and alloys.

Continental Can Co. (Inc.), Research Department, 4633 West Grand Avenue, Chicago, Ill.
  Corrosion of tin plate.
  Perforation of tin containers packed with acid foods.
  Discoloration of tin plate by decomposition of products during processing of canned foods.
  Chemical composition and physical condition of tin plate with respect to its service value in food containers.

Duquesne Light Co. (in cooperation with the American Society for Testing Materials), Pittsburgh, Pa.
  Galvanic and electrolytic corrosion of nonferrous metals and alloys.
  Atmospheric corrosion of nonferrous metals and alloys.

Duriron Co. (in cooperation with the American Society for Testing Materials), Dayton, Ohio.
  Corrosion of nonferrous metals and alloys in liquids.

General Electric Co. (in cooperation with the American Society for Testing Materials), West Lynn, Mass.
  Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
  Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
  Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

General Motors Research Corporation (in cooperation with the American Society for Testing Materials), Detroit, Mich.
  Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
  Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
  Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

General Motors Research Laboratories, General Motors Building, Detroit, Mich.
  Development of bearing alloy with frictional quality of babbitt and possessing a high softening point.

Harvard University, Cambridge, Mass.
Corrosion of copper and brass water pipes.

The Hoover Co. (in cooperation with the American Society for Testing Materials), North Canton, Ohio.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc base alloys with exposure test data.

International Lead Refining Co., 151st and McCook Avenues, East Chicago, Ind.
Corrosion of lead and lead alloys.

International Nickel Co. (in cooperation with the American Society for Testing Materials), New York, N. Y.
Corrosion of nonferrous metals and alloys in liquids.

Massachusetts Institute of Technology, Cambridge, Mass
Mechanism of electrolytic prevention of brass corrosion in steam condensers.

Massachusetts Institute of Technology (in cooperation with the American Society for Testing Materials), Cambridge, Mass.
Corrosion of nonferrous metals and alloys in liquids.

National Advisory Committee for Aeronautics (in cooperation with the United States Bureau of Standards, the United States Army and the United States Navy), Washington, D. C.
Corrosion embrittlement of sheet duralumin.
Corrosion of magnesium and magnesium alloys.

National Lead Co., Research Laboratories, 105 York Street, Brooklyn, N. Y.
Corrosion and metallography of lead, tin, and/or antimony alloys.

National Lead Co. (in cooperation with the American Society for Testing Materials), Brooklyn, N. Y.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum base-alloys and 9 zinc-base alloys after 1, 3 and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

The New Jersey Zinc Co. (in cooperation with the American Society for Testing Materials), Palmerton, Pa.
- Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
- Tension and impact tests on die cast test specimens from 12 aluminum base-alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
- Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

University of Notre Dame, Notre Dame, Ind.
- Effect of small amounts of copper upon susceptibility of lead to corrosion by sulphuric acid.

Packard Motor Car Co. (in cooperation with the American Society for Testing Materials), Detroit, Mich.
- Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
- Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
- Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

Pennsylvania State College (in cooperation with the American Society for Testing Materials), State College, Pa.
- Galvanic and electrolytic corrosion of nonferrous metals and alloys.
- Atmospheric corrosion of nonferrous metals and alloys.

Pennsylvania Railroad Co. (in cooperation with the American Society for Testing Materials), Altoona, Pa.
- Galvanic and electrolytic corrosion of nonferrous metals and alloys.
- Atmospheric corrosion of nonferrous metals and alloys.

Rochester Gas & Electric Corporation (in cooperation with the American Society for Testing Materials), Rochester, N. Y.
- Galvanic and electrolytic corrosion of nonferrous metals and alloys.
- Atmospheric corrosion of nonferrous metals and alloys.

Southern Counties Gas Co., 810 South Flower Street, Los Angeles, Calif.
- Copper pipe for natural-gas distribution systems in corrosive soils.

Stewart Die Casting Corporation (in cooperation with the American Society for Testing Materials), Chicago, Ill.
- Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
- Tension and impact tests on die cast test specimens from 12 aluminum base-alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

Stewart Die Casting Corporation-- Continued.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

Tubize-Chatillon Corporation, Rome, Ga.
Resistance of aluminum and its alloys to corrosion by acetic acid and sulphuric acid.
Resistance of copper alloys to corrosion by acetic acid and mixtures containing salts.

United States Army, Fort Hancock (in cooperation with the American Society for Testing Materials), Sandy Hook, N. J.
Galvanic and electrolytic corrosion of nonferrous metals and alloys.
Atmospheric corrosion of nonferrous metals and alloys.

United States Army (in cooperation with the United States Bureau of Standards, the United States Navy, and the National Advisory Committee for Aeronautics), Washington, D. C.
Corrosion embrittlement of sheet duralumin.
Corrosion of magnesium and magnesium alloys.

United States Army Air Corps (in cooperation with the American Society for Testing Materials), Dayton, Ohio.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years out-door exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

United States Bureau of Standards, Washington, D. C.
Corrosion problems arising in the use of sheet copper for roofing and flashings.
Investigation of the strnegth of the soldered seams of copper roofing and the corrosion of valley flashings.
Wear resistance and related properties of bearing bronzes.
Exposure tests of art bronzes.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D. C.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.
Exposure tests on nonferrous metals and alloys.

United States Bureau of Standards (in cooperation with the United States Army, the United States Navy, and the National Advisory Committee for Aeronautics), Washington, D. C.
- Corrosion embrittlement of sheet duralumin.
- Corrosion of magnesium and magnesium alloys.

United States Navy Department (in cooperation with the American Society for Testing Materials), Key West, Fla.
- Galvanic and electrolytic corrosion of nonferrous metals and alloys.
- Atmospheric corrosion of nonferrous metals and alloys.

United States Navy Yard, Material Branch (in cooperation with the American Society for Testing Materials), Washington, D. C.
- Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
- Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
- Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

United States Navy (in cooperation with the United States Bureau of Standards, the United States Army, and the National Advisory Committee for Aeronautics), Washington, D. C.
- Corrosion embrittlement of sheet duralumin.
- Corrosion of magnesium and magnesium alloys.

Western Electric Co. (Inc.) (in cooperation with the American Society for Testing Materials), Chicago, Ill.
- Corrosion resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
- Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
- Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

Westinghouse Electric & Manufacturing Co. (in cooperation with the American Society for Testing Materials), East Pittsburgh, Pa.
- Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
- Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
- Correlation of accelerated corrosion tests of zinc-base alloys with exposure test data.

White Motor Co. (in cooperation with the American Society for Testing Materials), Cleveland, Ohio.
Corrosion-resisting properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.
Correlation of accelerated corrosion tests of zinc-base alloys with exposure-test data.

VI. Properties: Failure, Endurance, Fatigue, and Crystal Structure

American Chain Co. (Inc.), Bridgeport, Conn.
Resistance to fatigue of carbon and alloy steels.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and the University of Illinois), 29 West 39th Street, New York, N. Y.
Effect of temperature upon the fatigue or endurance properties of metals.
Fatigue tests on a low-carbon steel at high temperature.

American Society of Mechanical Engineers (in cooperation with the United States Navy), 29 West 39th Street, New York, N. Y.
Tests on cylindrical structures subjected to collapse.

American Society of Mechanical Engineers (in cooperation with industrial laboratories), 29 West 39th Street, New York, N. Y.
Fatigue tests of springs.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers, and the University of Illinois), 1315 Spruce Street, Philadelphia, Pa.
Effect of temperature upon the fatigue or endurance properties of metals.
Fatigue tests on a low-carbon steel at high temperatures.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Endurance properties of special steels.
Low-temperature properties of aircraft materials, including fatigue, impact, tensile, and other properties.

Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.
Causes of chain breakage.

Carnegie Institute of Technology, Bureau of Metallurgical Research, Schenley Park, Pittsburgh, Pa.
Recrystallization in metals after cold-working and heating.

Case School of Applied Science, University Circle, Cleveland, Ohio.
The effects of small amounts of cold work on the crystallization temperatures of type AA enduro steel (18 per cent Cr, low carbon).

University of Colorado, Boulder, Colo.
Effect of stressing steel encased in concrete above its yield point.

Detroit Edison Co. (in cooperation with the University of Michigan), 2000 Second Avenue, Detroit, Mich.
Causes of failures of boiler tubes.

Four Wheel Drive Auto Co., Clintonville, Wis.
Endurance properties of commercial malleable iron, as compared with straight-carbon cast steel.

General Electric Co., Research Laboratory, Schenectady, N. Y.
The relation, if any, of impact value to notched fatigue.
The corrosion fatigue of steels in steam.

Harvard University, Cambridge, Mass.
Metallographic investigation of rail failures.

University of Illinois, Urbana, Ill.
Fatigue tests of steel at elevated temperatures.
Determination of the general laws and phenomena of the fatigue of metals.
Study of the Ikeda (electrical resistance) short-time test for fatigue-strength of metals.

University of Illinois (in cooperation with the American Society of Mechanical Engineers and the American Society for Testing Materials), Urbana, Ill.
Fatigue tests on a low-carbon steel at high temperatures.

University of Illinois, Engineering Experiment Station (in cooperation with the American Society for Testing Materials and the American Society of Mechanical Engineers), Urbana, Ill.
Effect of temperature upon the fatigue or endurance properties of metals.

Lehigh University, Department of Metallurgical Engineering, Bethlehem, Pa.
Protective values of cadmium and zinc platings against corrosion-fatigue of steel.
Effect of hydrogen absorbed during pickling upon life of steel subjected to fatigue.
Corrosion-fatigue tests of welded joints.

University of Maine, Orono, Me.
Effect of repeatedly stressing metals beyond yield point, in torsion, and tension.

Marquette University, College of Engineering, 1210 West Michigan Street, Milwaukee, Wis.
Causes of failures in locomotive tires.

Massachusetts Institute of Technology, Department of Mining and Metallurgy, 69 Massachusetts Avenue, Cambridge, Mass.
The intercrystalline failure of metals.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
Theory of metal recrystallization and effects of presence of impurities.

University of Michigan (in cooperation with the Detroit Edison Co.), Ann Arbor, Mich.
Causes of failures of boiler tubes.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
Grain growth in metals and alloys.

Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn, N. Y.
Effect of frequency on the fatigue limit of steel by rise in temperature and increase in electrical resistance.

Public Service Electric & Gas Co., Newark, N. J.
Development of fatigue-testing machine for bolt material.

Purdue University, Lafayette, Ind.
Fatigue study.

Rensselaer Polytechnic Institute, Troy, N. Y.
Preparation of single crystals of metallic compounds.

Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Engineering, Troy, N. Y.
Study of the relationship between cold working, annealing, and crystal size in brasses.

Stanford University, Stanford University, Calif.
Grain structure and cracks in chromium plating.

Union College, Schenectady, N. Y.
Properties of metallic single crystals.

United States Bureau of Standards, Washington, D. C.
Endurance limits of metals in axial loading and rotary bending.
Failure in service of heat-treated bridge wire.
Fatigue properties of duralumin coated with aluminum.
The relation of corrosion and fatigue of metals.
Crystal structure of metals by X-ray methods.

United States Bureau of Standards (in cooperation with Yale University), Washington, D. C.
Fatigue properties of thin sheet duralumin for aircraft use.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
The effects of various degrees of cold working on stainless steels, especially the torsional fatigue properties when in the form of elliptical wire.
The effects of variable amounts of oxygen in water on the corrosion-fatigue limit of boiler steel.

United States Navy (in cooperation with the American Society of Mechanical Engineers), Washington, D. C.
Tests on cylindrical structures subjected to collapse.

State College of Washington, Pullman, Wash.
Fatigue tests of metals.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
Study of welded metals under fatigue tests.

Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Fatigue tests of model turbine-generator rotors.
Fatigue and impact tests of welds.

Yale University (in cooperation with United States Bureau of Standards), Washington, D. C.
Fatigue properties of thin sheet duralumin for aircraft use.

VII. Properties: Other Mechanical

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.
Grinding tests on iron and alloys.
Wearing test of chilled cast iron under conditions of impact and abrasion.

Allis-Chalmers Manufacturing Co. (in cooperation with the University of Michigan), Milwaukee, Wis.
Intermittent creep tests of 500 pounds per square inch at 850° F. for 2,000 hours on forged and cast steels.
Creep-test analysis at elevated temperature on materials suitable for large stationary and rotating structures.
Separate single-load creep tests for each load arrived at in increments of loading in the original creep tests.

Aluminum Co. of America (in cooperation with the American Society for Testing Materials), New Kensington, Pa.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

American Brass Co. (in cooperation with the American Society for Testing Materials), Waterbury, Conn.
  Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3 and 5 years outdoor exposure at 6 places and indoor exposure at 4.

American Cast Iron Pipe Co. (in cooperation with the American Society for Testing Materials), Birmingham, Ala.
  Chemical analyses, transverse tests, impact tests, and hardness determinations on cast iron.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and the Battelle Memorial Institute), 29 West 39th Street, New York, N. Y.
  Creep of metals at elevated temperatures.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and various industrial laboratories), 29 West 39th Street, New York, N. Y.
  Development of a test code for high-temperature tensile and creep tests.
  High-temperature effects on mechanical properties and structural stability of cast, wrought, and stainless steel.

American Society of Mechanical Engineers (in cooperation with the American Society for Testing Materials and 13 manufacturers), 29 West 39th Street, New York, N. Y.
  Comparative high-temperature short-time tension tests.

American Society of Mechanical Engineers (in cooperation with the Carnegie Institute of Technology and various industrial laboratories), 29 West 39th Street, New York, N. Y.
  Forces in the cold rolling of nonferrous metals.
  Roll neck forces in hot rolling alloy steels.

American Society of Mechanical Engineers (in cooperation with the Carnegie Institute of Technology), 29 West 39th Street, New York, N. Y.
  Forces and stresses in roll-neck bearings.

American Society of Mechanical Engineers (in cooperation with the Massachusetts Institute of Technology, the Engineering Foundation, and industrial laboratories), 29 West 39th Street, New York, N. Y.
  Strength of gear teeth.

American Society of Mechanical Engineers (in cooperation with Union College), 29 West 39th Street, New York, N. Y.
  Elasticity of spring materials.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
  Elastic properties of electrical-resistance alloys.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and the Battelle Memorial Institute), 1315 Spruce Street, Philadelphia, Pa.
Creep of metals at elevated temperatures.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and 13 manufacturers), 1315 Spruce Street, Philadelphia, Pa.
Comparative high-temperature short-time tension tests.

American Society for Testing Materials (in cooperation with the American Society of Mechanical Engineers and various industrial laboratories), 29 West 39th Street, New York, N. Y.
High-temperature effects on mechanical properties and structural stability of cast, wrought, and stainless steel.
Development of a test code for high-temperature tensile and creep tests.

American Society for Testing Materials (in cooperation with Deere & Co.), 1315 Spruce Street, Philadelphia, Pa.
Falling weight drop tests on cast iron.

American Society for Testing Materials (in cooperation with Rensselaer Polytechnic Institute, Bethlehem Steel Company, Illinois Steel Company, and the University of Wisconsin) 1315 Spruce Street, Philadelphia, Pa.
Yield point of structural steel.

American Society for Testing Materials (in cooperation with 16 industrial and governmental laboratories), 1315 Spruce Street, Philadelphia, Pa.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

American Society for Testing Materials (in cooperation with 13 industrial, university and government laboratories), 1315 Spruce Street, Philadelphia, Pa.
Impact tests, hardness determinations, compression tests, and other determinations on cast iron.

Babcock & Wilcox Co., 85 Liberty Street, New York, N. Y.
Creep of steel.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Low-temperature properties of aircraft materials, including fatigue, impact, tensile and other properties.

Battelle Memorial Institute (in cooperation with the American Society for Testing Materials and the American Society of Mechanical Engineers), 505 King Avenue, Columbus, Ohio.
Creep of metals at elevated temperatures.

Bell Telephone Laboratories, Incorporated (in cooperation with the American Society for Testing Materials), New York, N. Y.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

Bethlehem Steel Co. (in cooperation with the American Society for Testing Materials, Rensselaer Polytechnic Institute, Illinois Steel Co., and the University of Wisconsin), Bethlehem, Pa.
Yield point of structural steel.

Bunting Brass and Bronze Co. (in cooperation with the United States Bureau of Standards), Toledo, Ohio.
Resistence to impact of bronze alloys.
Resistence to repeated pounding of bronze alloys.

California Institute of Technology, Pasadena, Calif.
Investigation of strength and hardness relationships of certain solid solution proportions of the noble metals.

California Institute of Technology, Department of Mechanics, Pasadena, Calif.
Investigation to determine whether Shore scleroscope would show different rebounds for specimens under stress and specimens not under stress.

Carnegie Institute of Technology, Bureau of Metallurgical Research, Schenley Park, Pittsburgh, Pa.
The effect of cold-working and reheating on the hardness of steels.
Mechanical properties of steels.
The effect of nonmetallic impurities on deformation in metals.

Carnegie Institute of Technology (in cooperation with the American Society of Mechanical Engineers), Schenley Park, Pittsburgh, Pa.
Forces and stresses in roll-neck bearings.

Carnegie Institute of Technology (in cooperation with the American Society of Mechanical Engineers and various industrial laboratories), Pittsburgh, Pa.
Forces in the cold rolling of nonferrous metals.
Roll neck forces in hot rolling alloy steels.

Catholic University of America, Washington, D. C.
Study of locked-up stresses caused by welding heat.

Crane Company Laboratory, 836 South Michigan Avenue, Chicago, Ill.
Long-time tension tests of steels at elevated temperatures.

Deere & Co. (in cooperation with the American Society for Testing Materials), Moline, Ill.
Falling weight drop tests on cast iron.

The Engineering Foundation (in cooperation with the American Society of Mechanical Engineers), 29 West 39th Street, New York, N. Y.
    Strength of gear teeth.

Firth-Sterling Steel Co., McKeesport, Pa.
    Cutting properties of tungsten and tantalum hard-metal compositions.

General Electric Co., Research Laboratory, Schenectady, N. Y.
    The relation, if any, of impact value to notched fatigue.
    The effect of heat treatment on impact value.
    Characteristics of various steels under torsion and at elevated temperatures.
    Causes of brittleness in medium silicon steel sheet (Si 2.5-4 per cent).

General Electric Co. (in cooperation with the American Society for Testing Materials), West Lynn, Mass.
    Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

General Motors Co. (in cooperation with the American Society for Testing Materials), Detroit, Mich.
    Unnotched Charpy impact tests on cast iron.

General Motors Research Corporation (in cooperation with the American Society for Testing Materials), Detroit, Mich.
    Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

The Geometric Tool Co., New Haven, Conn.
    Alloy steels, particularly high-speed steels, and their machining qualities.
    The machining qualities of alloys of copper and aluminum.

The Hoover Co. (in cooperation with the American Society for Testing Materials), North Canton, Ohio.
    Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

University of Illinois (in cooperation with the American Society for Testing Materials), Urbana, Ill.
    Izod impact tests and compression tests on cast iron.

University of Illinois, Engineering Experiment Station (in cooperation with the Utilities Research Commision, Incorporated), Urbana, Ill.
Stretching (creep) of lead cable sheath under prolonged stress.

Illinois Steel Co. (in cooperation with the American Society for Testing Materials, Rensselaer Polytechnic Institute, Bethlehem Steel Co., and the University of Wisconsin), 208 South LaSalle Street, Chicago, Ill.
Yield point of structural steel.

International Lead Refining Co., 151st and McCook Avenue, East Chicago, Ind.
Mechanical properties of lead alloys.

International Nickel Co. (in cooperation with the American Society for Testing Materials), 67 Wall Street, New York, N. Y.
Notched Charpy tests on cast iron.

Lafayette College, Easton, Pa.
An investigation of a high tensile strength cast iron.

Lunkenheimer Co. (in cooperation with the American Society for Testing Materials), Beekman Street and Waverly Avenue, Cincinnati, Ohio.
Tensile tests, shear tests, and falling weight drop tests on cast iron.

Lynchburg Foundry Co. (in cooperation with the American Society for Testing Materials), Lynchburg, Va.
Tension tests of cast iron.

Maine State Highway Department, Orono, Me.
Determination of a unit working stress for hooked reinforcing steel for concrete.

University of Maine, Orono, Me.
Effect of hot twisting on the strength and structure of iron and steel.
Effect of repeatedly stressing metals beyond yield point in torsion and tension.

Massachusetts Institute of Technology (in cooperation with the American Society of Mechanical Engineers and industrial laboratories), Cambridge, Mass.
Strength of gear teeth.

University of Michigan, Ann Arbor, Mich.
Strength of ductile materials subjected to shear at elevated temperatures.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Effect of temperature on tensile strength of lead.
The machinability of malleable cast iron.

University of Michigan (in cooperation with the Allis-Chalmers Manufacturing Co.), Ann Arbor, Mich.
  Intermittent creep tests of 500 pounds per square inch at 850°F. for 2,000 hours on forged and cast steels.
  Creep-test analysis at elevated temperature on materials suitable for large stationary and rotating structures.
  Separate single-load creep tests for each load arrived at in increments of loading in the original creep tests.

University of Michigan (in cooperation with the American Society for Testing Materials), Ann Arbor, Mich.
  Notched Izod impact tests on cast iron.

University of Minnesota, College of Engineering and Architecture, Minneapolis, Minn.
  Plastic and elastic deformation of ferrous metals.

Montana State School of Mines, Butte, Mont.
  Relation between Brinell, Rockwell, scleroscope, and scratch hardnesses of certain minerals.

Montana State School of Mines, State Bureau Mines and Geology, Butte, Mont.
  Hard and soft states of metals.

The National Lead Co. (in cooperation with the American Society for Testing Materials), Brooklyn, N. Y.
  Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

The New Jersey Zinc Co. (in cooperation with the American Society for Testing Materials), Palmerton, Pa.
  Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

Northwestern University, Evanston, Ill.
  Effect of shrinkage as a controlling factor in increases of compressive reinforcing steel deformation with continued load.

Packard Motor Car Co. (in cooperation with the American Society for Testing Materials), Detroit, Mich.
  Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

University of Pittsburgh, Pittsburgh, Pa.
  Stress distribution in fillet welds.

Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn, N. Y.
Effect of low temperature annealing time on torsional properties of music wire.
Effect of original grain size of low-carbon steel on tensile properties at elevated temperatures.
The core effect on the experimentally determined hardness values of nitrided-steel cases.

Polytechnic Institute of Brooklyn, Department of Civil Engineering, 99 Livingston Street, Brooklyn, N. Y.
Investigation of the torsional strength of metals at high temperature.

Rensselaer Polytechnic Institute, Troy, N. Y.
Investigation of the torsional strength of the metals at high temperature.
Internal stress produced by fillet welds made by metallic arc.

Rensselaer Polytechnic Institute (in cooperation with the American Society for Testing Materials, the Bethlehem Steel Co., the Illinois Steel Co., and the University of Wisconsin), Troy, N. Y.
Yield point of structural steel.

Spicer Manufacturing Corporation, 4100 Bennett Road, Toledo, Ohio.
Strengths and critical speeds of propeller shafts for motor cars and similar applications.

Stewart Die Casting Corporation (in cooperation with the American Society for Testing Materials), Chicago, Ill.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

Union College (in cooperation with the American Society of Mechanical Engineers) Schenectady, N. Y.
Elasticity of spring materials.

United States Army Air Corps (in cooperation with the American Society for Testing Materials), Dayton, Ohio.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

United States Bureau of Standards, Washington, D. C.
Effect of excessive cold working on the hardness of metals.
Compression properties and impact resistance of metals at high temperatures.
Notch propagation in coated metals.
Physical and mechanical properties of sprayed metal.
Load-carrying capacity of journal bearings.
Principles of the machinability of metals.
Strength of aircraft tubing.

United States Bureau of Standards--Continued.
- Torsional strength and other properties of thin-walled tubing for use in aircraft.
- Investigation of the effect of the restraining moments of ends of columns upon compressive strength (end fixation of struts).
- Inelastic behavior of duralumin and alloy steel in tension and compression.
- Properties of rail steel, with special reference to transverse fissures.
- Flow characteristics of iron-nickel and chromium alloys and steels at elevated temperatures.
- Creep in alloy steels under load at high temperature.
- Investigation of the strength and other properties of wires making up the cable strands for suspension bridges.
- The compressive strength and deformation of structural steel and cast-iron shapes at high temperatures.
- Effects of variations in composition on cutting tests of high-speed tool steels.
- The strength of welded rail joints.
- Resistance of rectangular plates of duralumin of different thickness to bulging under normal pressure.
- Strength and other properties of duralumin channels and sections used in aircraft construction.
- The strength of welded joints in steel tubes for use in aircraft.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D. C.
- Charpy impact tests and direct tensile impact tests on cast iron.
- Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

United States Bureau of Standards (in cooperation with the Bunting Brass and Bronze Co.), Washington, D. C.
- Resistance to impact of bronze alloys.
- Resistance to repeated pounding of bronze alloys.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
- Investigation of effect of stress, time, and number of cycles in causing penetration of metal under corrosion.
- Investigation of the effects of various degrees of cold working on stainless steels, especially the torsional-fatigue properties when in the form of elliptical wire.
- Long-time creep test of nonferrous metals.

United States Navy Yard, Material Branch (in cooperation with the American Society for Testing Materials), Washington, D. C.
- Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

Utilities Research Commission, Incorporated (in cooperation with the University of Illinois), Room 522, 72 West Adams Street, Chicago, Ill.
Stretching (creep) of lead cable sheath under prolonged stress.

Walworth Alabama Co., Attalla, Ala.
The effect of phosphorus on the strength of high-test gray iron.
Development of high-test gray iron having maximum strength.

Western Electric Co. (Inc.) (in cooperation with the American Society for Testing Materials), Chicago, Ill.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

Westinghouse Electric & Manufacturing Co. (in cooperation with the American Society for Testing Materials), East Pittsburgh, Pa.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

White Motor Co. (in cooperation with the American Society for Testing Materials), Cleveland, Ohio.
Tension and impact tests on die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys after 1, 3, and 5 years outdoor exposure at 6 places and indoor exposure at 4.

University of Wisconsin (in cooperation with the American Society for Testing Materials), Madison, Wisconsin.
Fatigue tests and Russell impact tests on cast iron.

University of Wisconsin, Materials Testing Laboratory (in cooperation with the American Society for Testing Materials, Rensselaer Polytechnic Institute, Bethlehem Steel Company, and Illinois Steel Company), Madison, Wis.
Yield point of structural steel.

Yale University, Department of Mechanical Engineering, New Haven, Conn.
Analysis of stresses in steel-pipe flanges and fittings, preparatory to the adoption of standard proportions.

Yale University, Sloane Physics Laboratory, New Haven, Conn.
Elastic constants of single crystals of nickel and iron.

VIII. Properties: Miscellaneous

AC Spark Plug Co., Flint, Mich.
Physical properties of nonferrous alloys.

University of Akron, Department of Chemistry, Akron, Ohio.
Properties of pure Fe-Cr alloys.
Diffusion of chromium and iron.

Aluminum Co. of America, Aluminum Research Laboratories, Box 77, New Kensington, Pa.
Metallurgy of aluminum and its alloys.
Engineering properties and applications of aluminum and its alloys.

Aluminum Co. of America (in cooperation with the American Society for Testing Materials), New Kensington, Pa.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Aluminum Industries (Inc.), 2416-38 Beekman Street, Cincinnati, Ohio.
Physical properties of aluminum alloys.

American Brass Co. (in cooperation with the American Society for Testing Materials), Waterbury, Conn.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

American Can Co., Research Department, 11th Avenue and St. Charles Road, Maywood, Ill.
The physical properties and chemical composition of tin plate and black iron sheets to determine the improvements necessary for certain usages.
Compositions and properties of solders.

American Chain Co. (Inc.), Bridgeport, Conn.
Influence of welding conditions and subsequent heat-treatment on the structure of welds.

American Dental Association (in cooperation with the United States Bureau of Standards), 58 East Washington Street, Chicago, Ill.
Study of dental materials for the establishment of specifications and standards for these materials.

American Foundrymen's Association (in cooperation with the United States Bureau of Standards), 222 West Adams Street, Chicago, Ill.
Determination of the amount of liquid shrinkage of certain specified mixtures.

American Foundrymen's Association (in cooperation with the Nonferrous Ingot Metal Institute, the United States Bureau of Standards, and the American Society for Testing Materials), 222 West Adams Street, Chicago, Ill.
Physical properties of copper alloys in ingot form.

American Hammered Piston Ring Co., Box 758, Baltimore, Md.
Alloying properties.

American Society of Mechanical Engineers (in cooperation with The Engineering Foundation and the University of Michigan), 29 West 39th Street, New York, N. Y.
Relations between the physical and chemical characteristics of cutting fluids and their performance.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
Correlation of properties of iron castings and test bars.

American Society for Testing Materials (in cooperation with the American Foundrymen's Association, Nonferrous Ingot Metal Institute, and the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Physical properties of copper alloys in ingot form.

American Society for Testing Materials (in cooperation with Columbia University), 1315 Spruce Street, Philadelphia, Pa.
Effect of lead on standard Navy babbitt.

American Society for Testing Materials (in cooperation with the United States Bureau of Standards), 1315 Spruce Street, Philadelphia, Pa.
Properties of babbitt metal.

American Society for Testing Materials (in cooperation with 16 industrial and governmental laboratories), 1315 Spruce Street, Philadelphia, Pa.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Association of Manufacturers of Chilled Car Wheels, 1847 McCormick Building, Chicago, Ill.
Effect of additions of nickel, silicon, molybdenum, chrome, and vanadium to chilled tread wheel mixtures.

Bagdad Copper Corporation, Hillside, Ariz.
Physical characteristics of electrolytic copper as prepared by the Weatherbee process.

Barber-Colman Co., Rockford, Ill.
Relationship between heat treatment and physical properties of high-speed steel, also various other steels.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Comprehensive study of the properties of cast irons with a view to developing iron of superior quality, especially with reference to properties at elevated temperatures.

Battelle Memorial Institute (in cooperation with the Engineering Foundation and 10 technical societies), 505 King Avenue, Columbus, Ohio.
Collection and codification of known information on alloys of iron.

Bell Telephone Laboratories (Inc.) (in cooperation with the American Society for Testing Materials), New York, N. Y.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Bunting Brass & Bronze Co. (in cooperation with the United States Bureau of Standards), Toledo, Ohio.
Effect of impurities on bronze alloys.

California Institute of Technology, Pasadena, Calif.
Determination of the difference in the constitution of sorbite and troostite.

Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.
The influence of sulphur dioxide on the solubility of tin oxide.

Carnegie Institute of Technology, Bureau of Metallurgical Research, Schenley Park, Pittsburgh, Pa.
Studies of the constitution of high-manganese steels, of chrome steels, and of high-nickel steels.
The effect of composition on the critical points of stainless steels.
The study of normal and abnormal steels.
The effect of nonmetallic impurities on deformation in metal.
The determination of the crystal structure of several important intermetallic compounds, including magnesium plumbide, magnesium dizincide, Cu_2Mg, $CuAl_2$, and iron phosphide.
The analysis of the arc spectra in iron, nickel and cobalt.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
A study of high-temperature solders for special applications in the zone from 400 to 1000° F. and brazes for applications in the zone from 1300 to 1800° F., including physical properties, application to various metals, etc.

University of Chicago, Kent Chemical Laboratory, Chicago, Ill.
The physical and chemical properties of the compounds of gallium and germanium.
The chemistry of gallium and germanium.

Columbia University (in cooperation with the American Society for Testing Materials), New York, N. Y.
Effect of lead on standard Navy babbitt.

Detroit Edison Co. (in cooperation with University of Michigan), 2000 Second Avenue, Detroit, Mich.
Long-time tests of pipe-line flange bolts in service.

Detroit Lubricator Co., 5842 Trumbull Avenue, Detroit, Mich.
The effect of impurities in foundry bronzes.

Henry Disston & Sons (Inc.), Tacony, Philadelphia, Pa.
The influence of character and source of raw materials on the quality of tool steel made in electric furnace.

The Duriron Co. (Inc.), Dayton, Ohio.
Effect of nonmetallic inclusions on the properties of high-silicon iron.

Engineering Foundation, 29 West 39th Street, New York, N. Y.
Buckling strength of outstanding flanges and plates.
Alloys of iron research.

Engineering Foundation (in cooperation with the American Society of Mechanical Engineers), 29 West 39th Street, New York, N. Y.
Relations between the physical and chemical characteristics of cutting fluids and their performance.

General Electric Co., Research Laboratory, Schenectady, N. Y.
Determination of causes for "fish-scale" in high-speed steel.
Construction of Co-C diagram.
Effect of small percentages of bismuth on the chemical and physical properties of lead, and lead alloys.
Characteristics of silicon-steel sheets.
The nature of nitrogen needles.

General Electric Co. (in cooperation with the American Society for Testing Materials), West Lynn, Mass.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

General Motors Research Corporation (in cooperation with the American Society for Testing Materials), Detroit, Mich.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Harvard University, Cambridge, Mass.
Structure studies on gold telluride.
Influence of elements on the eutectoid point of steel.
Influence of calcium and oxygen on iron and steel.
Aging of iron and steel.

Harvard University, Harvard Engineering School, Rotch Building, Cambridge, Mass.
Microscopical characters as guides to methods of treatment of ore.
Manner of occurrence of mineral constituents.

The Hoover Co. (in cooperation with the American Society for Testing Materials), North Canton, Ohio.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Hupp Motor Car Corporation, Detroit, Mich.
Physical properties of solders from 0 to 350° F.

International Lead Refining Co., 151st and McCook Avenue, East Chicago, Ind.
Investigation of properties of bismuth alloys.
Properties of common lead.

International Motor Co., New Brunswick, N. J.
The effect of certain virgin aluminums on localized shrinks producing porosity.

The International Nickel Co. (Inc.), Development and Research Department, 67 Wall Street, New York, N. Y.
Effect of nickel on bronzes.

State University of Iowa, Department of Chemistry, Iowa City, Iowa.
Properties of alloys of barium and of strontium.
Effects of silicon on the properties of brass.

University of Kentucky, Department of Mines and Metallurgy, Lexington, Ky.
A study of the physical effects of the addition to aluminum of relatively small amounts of various alloying substances, including melting procedure, heat treatment, and physical and microscopic testing in both the cast and worked conditions.

Lehigh University, Department of Metallurgical Engineering, Bethlehem, Pa.
The iron-silicon equilibrium diagram.
The properties of pure, gas-free iron in arc welding.

University of Maine, Orono, Me.
The properties of molybdenum steel.

Marquette University, College of Engineering, 1210 West Michigan Street, Milwaukee, Wis.
Correlation of structure and physical properties with respect to the principal bearing metals and alloys.

Metals Coating Co. of America, 497 North 3rd Street, Philadelphia, Pa.
Physical and chemical properties of sprayed molten metal coatings.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
Rates of diffusion of carbon, phosphorus and sulphur into iron and the pressure, temperature, concentration relations.

Michigan College of Mining and Technology--Continued.
Study of copper-silver alloy system.
X-ray study of cast copper.
The system copper-cuprous oxide.

University of Michigan, Ann Arbor, Mich.
The physical properties and behavior of materials for heavy plates for boiler drums.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Properties and behavior of materials now used for turbine blades.
Long-time tests of pipe-line flange bolts.
Study of the strength and related properties of ferrous and nonferrous metals at elevated temperatures.

University of Michigan (in cooperation with the American Society of Mechanical Engineers), Ann Arbor, Mich.
Relations between the physical and chemical characteristics of cutting fluids and their performance.

University of Michigan (in cooperation with the Detroit Edison Co.), Ann Arbor, Mich.
Long-time tests of pipe-line flange bolts in service.

University of Michigan, Department of Engineering Research (in cooperation with the Utilities Research Commission (Inc.), Ann Arbor, Mich.
Permeability of alloy retorts to various gases.

The Midvale Co., Nicetown, Philadelphia, Pa.
Effect of factors in heat-treatment on physical properties of steel.
Effect of additions of alloys on properties of steel.

University of Minnesota, School of Chemistry, Minneapolis, Minn.
Use of X-ray methods in determination of the crystal structure of nickel silicate, nickel titanate, zinc titanate, zinc stannate.
Application of X-rays in the study of various metallurgical problems.

Montana State School of Mines, Butte, Mont.
The constitution and structure of the ternary mattes Cu_2S-PbS-Sb_2S_3, with especial reference to specific gravity.

The National Lead Co. (in cooperation with the American Society for Testing Materials), Brooklyn, N. Y.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

National Slag Association, 937 Leader Building, Cleveland, Ohio.
Physical and chemical properties of slags.

The New Jersey Zinc Co. (in cooperation with the American Society for Testing Materials), Palmerton, Pa.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Nonferrous Ingot Metal Institute (in cooperation with the United States Bureau of Standards, the American Foundrymen's Association and the American Society for Testing Materials), 308 West Washington Street, Chicago, Ill.
Physical properties of copper alloys in ingot form.

The Ohio State University, Engineering Experiment Station, Columbus, Ohio.
Properties of alloys.
X-ray analysis of alloy steels.

Packard Motor Car Co. (in cooperation with the American Society for Testing Materials), Detroit, Mich.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

The Peoples Gas Light & Coke Co., 122 South Michigan Avenue, Chicago, Ill.
Effects of gases on metals.

Pfanstiehl Chemical Co., Manufacturers Terminal, Waukegan, Ill.
General study of the alloys of the rarer metals and elements with ferrous-metal bases.
The properties and uses of the rarer metals and their alloys.

Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn, N. Y.
Physical properties of certain sheet brass alloys, including the effect of rolling and annealing on these properties.

Rail Steel Bar Association, 228 North LaSalle Street, Chicago, Ill.
Effect of varying percentages of carbon and manganese on physical properties of finished products.
Effect of cooling rate and design of hot beds on physical properties of finished products.

Rensselaer Polytechnic Institute, Troy, N. Y.
Effects of annealing and heat treatment on physical properties of nickel and nickel alloys (precipitation hardening).
Physical properties of alloys of copper with iron and silicon.
Gases in metals particularly applied to pinholes in aluminum castings.
Properties of metallic zirconium.
Properties of modified silumin alloys.
Physical properties of nickel chromium alloys in the range of stainless steels.

Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Engineering, Troy, N. Y.
Study of the relationship between cold working, annealing, and crystal size in brasses.

Rhode Island Malleable Iron Works, Hills Grove, R. I.
Improvement of properties of malleable iron.

Stewart Die Casting Corporation (in cooperation with the American Society for Testing Materials), Chicago, Ill.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Taylor Wharton Iron & Steel Co., High Bridge, N. J.
Properties of nickel-manganese (austenitic) steels.

Union Carbide and Carbon Research Laboratories, Incorporated, 30 East 42nd Street, New York, N. Y.
Characteristics of alloy steels.

United States Army Air Corps (in cooperation with the American Society for Testing Materials), Dayton, Ohio.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

United States Bureau of Mines, Intermountain Experiment Station (in cooperation with the University of Utah), Salt Lake City, Utah.
Microscopic investigation of the mineral associations in the complex ores.

United States Bureau of Standards, Washington, D. C.
Properties of zinc and cadmium.
Chemical and physical properties of the platinum-group metals and their alloys.
Fluidity of cast iron
Critical review of literature of pure iron.
Properties of pure iron.
Physical constants of metals of unusual degrees of purity.
Preparation of an encyclopedia of specifications for metals and metal products.
Heats of formation of certain metallic oxides.
Solubility of gases in metals.

United States Bureau of Standards (in cooperation with the American Dental Association), Washington, D. C.
Study of dental materials for the establishment of specifications and standards for these materials.

United States Bureau of Standards (in cooperation with the American Foundrymen's Association), Washington, D. C.
Determination of the amount of liquid shrinkage of certain specified mixtures.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D. C.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.
Properties of babbitt metal.

United States Bureau of Standards (in cooperation with the Bunting Brass and Bronze Co.), Washington, D. C.
Effect of impurities on bronze alloys.

United States Bureau of Standards (in cooperation with the Nonferrous Ingot Metal Institute, the American Foundrymen's Association and the American Society for Testing Materials), Washington, D. C.
Physical properties of copper alloys in ingot form.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
The effect of surface defects.

United States Navy Yard, Material Branch (in cooperation with the American Society for Testing Materials), Washington, D. C.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
The chromium-nickel-iron series of alloys.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research (in cooperation with the United States Bureau of Mines), Salt Lake City, Utah.
Microscopic investigation of the mineral associations in the complex ores.

Utilities Research Commission (Inc.) (in cooperation with the University of Michigan), 72 West Adams Street, Chicago, Ill.
Permeability to various gases of alloy retorts.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Blacksburg, Va.
Properties of welded joints.

Wabash College, Department of Chemistry, Crawfordsville, Ind.
The composition of meteoritic irons from the region surrounding the Barringer meteorite.

Western Electric Co. (Inc.) (in cooperation with the American Society for Testing Materials), Chicago, Ill.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
Fatigue tests of fillet welds to determine effect of machining spacing and size of weld.
Fatigue and impact tests of welds.

Westinghouse Electric & Manufacturing Co. (in cooperation with the American Society for Testing Materials), East Pittsburgh, Pa.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

White Motor Co. (in cooperation with the American Society for Testing Materials), Cleveland, Ohio.
Physical properties of die cast test specimens from 12 aluminum-base alloys and 9 zinc-base alloys.

Yale University, Department of Mining and Metallurgy, 14 Mansfield Street, New Haven, Conn.
Constitution of silver-silicon alloys.
Directional properties in rolled and annealed copper sheet.
Equilibrium between iron and certain metallic oxides.

IX. Extraction and Refining

The Ajax Metal Co., 46 Richmond Street, Philadelphia, Pa.
Reclamation of scrap metals and recovery of by-products.

Aluminum Co. of America, Aluminum Research Laboratories, Box 77, New Kensington, Pa.
Preparation of pure alumina from bauxite and other aluminous materials.
Reduction of alumina to metallic aluminum.

American Can Co., Research Department, 11th Avenue and St. Charles Road, Maywood, Ill.
Methods for recovery of solder from solder by-products.

American Cyanamid Co., 535 Fifth Avenue, New York, N. Y.
Application of cyanide to gold and silver extraction.
Electrothermal recovery of zinc.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Recovery of tin from tin-bearing residues.

American Smelting & Refining Co., 120 Broadway, New York, N. Y.
Electrolytic refining of brass.
Processing electrolytic-lead slimes.
Production of liquid sulphur dioxide.
Treatment of fume bags to prolong life.

American Smelting & Refining Co.--Continued.
Refining of white arsenic.
Leaching copper-plant Cottrell dusts.
Treatment of lead-bullion drosses.
Zinc-retort practice.

University of Arizona (in cooperation with the United States Bureau of Mines), Tucson, Ariz.
Oxidation of copper concentrates.

Bagdad Copper Corporation, Hillside, Ariz.
Roasting of copper concentrates.
Cyanidation of concentrates.

Baker & Co. (Inc.), 54 Austin Street, Newark, N. J.
Best methods of separation and purification of the platinum metals.

J. T. Baker Chemical Co., North Broad Street, Phillipsburg, N. J.
Preparation of molybdenum and its compounds.
Preparation of tungsten and its compounds.

Bethlehem Foundry & Machine Co., Wedge Furnace Department, Bethlehem, Pa.
Drying and roasting of various ores and concentrates preparatory to blast-furnace or reverberatory-furnace treatment, leaching, electrolytic extraction, or other treatment.

Birmingham-Southern College, Department of Chemistry, Birmingham, Ala.
Relation of composition and fineness to the properties of blast furnace slag cements.

California Institute of Technology, Pasadena, Calif.
Purification of copper-leaching solutions.

University of California, Department of Mining and Metallurgy, Berkeley, Calif.
New possibilities in the desilverisation and refining of lead bullion.

Callite Products Co., 540 39th Street, Union City, N. J.
Extraction of tungsten from its ores.
Extraction of molybdenum from its ore by the sublimation processes.

Carus Chemical Co., LaSalle, Ill.
Efficient production of manganese salts from manganese ores.

Cerro de Pasco Copper Corporation, 44 Wall Street, New York, N. Y.
Extraction and purification of bismuth.
Roasting and leaching of low-grade silver ores.

University of Chicago, Kent Chemical Laboratory, Chicago, Ill.
Extraction of gallium and germanium from germanite ore.

Columbia University, Department of Chemical Engineering, New York, N. Y.
Extraction of beryllium, titanium, tungsten, columbium, tantalum, and vanadium from their ores.

University of Colorado, Boulder, Colo.
Methods for the extraction of tungstic acid from tungsten-bearing tin residues, such as those obtained in Cornwall.

The DeLaval Separator Co., Poughkeepsie, N. Y.
Recovery of tin in tinning processes.
Reclamation of bearing metals and type metals.

The Dorr Co., 247 Park Avenue, New York, N. Y.
Leaching of carnotite ores.
Leaching of chrysocolla.
Recovery of zinc from zinc skimmings.

Engineering Foundation (in cooperation with the University of Wisconsin), 29 West 39th Street, New York, N. Y.
Physical metallurgy of blast-furnace slags.

Erie City Iron Works, Erie, Pa.
Direct electric reduction of iron oxides.

Evans Wallower Zinc Co., Monsanto Post Office, East St. Louis, Ill.
Production of electrolytic zinc.

University of Florida, College of Pharmacy, Department of Chemistry, Gainesville, Fla.
Extraction of titanium and zirconium from their minerals.

Gas Industries Co., 2813 Penn Avenue, Pittsburgh, Pa.
Application of oxygen and oxygen enriched air to the production of metals in blast furnaces.

General Electric Co., 1 River Road, Schenectady, N. Y.
Commercial production of carbonless iron (C under 0.01).

General Electric Co., Research Laboratory, Schenectady, N. Y.
Refining of lead scrap.
Purification and reduction of tungsten and molybdenum oxides.
Production of caesium compounds.
Degassing metals, especially copper.

General Electric Vapor Lamp Co., 410 8th Street, Hoboken, N. J.
Purification of mercury to extreme degrees.

The Glidden Co., Cleveland, Ohio.
Zinc leaching.
Lead smelting.

Harshaw Chemical Co., 1945 East 97th Street, Cleveland, Ohio.
The extraction of chromite.

Inspiration Consolidated Copper Co., Inspiration, Ariz.
Making of ferric sulphate for leaching copper by electrolysis.

International Electric Smelter & Machine Co., 505-41 Park Row, New York, N.Y.
Electrolytic smelting and refining.
Electrochemical reduction of ores.

International Lead Refining Co., 151st and McCook Avenue, East Chicago, Ind.
Removal of bismuth from lead.
Production of refined bismuth.
Removal of zinc from desilverized lead and recovery of zinc in marketable form in the Parkes process of lead refining.
Removal of antimony from base bullion.
Refining antimony-lead alloys.
Production of metallic antimony.

International Smelting Co., Inspiration, Ariz.
Distribution and effect of magnetite in matte.
Chemical problems of copper metallurgy.
Leaching of copper ores and precipitation of copper.

State University of Iowa, Department of Chemistry, Iowa City, Iowa.
Recovery of beryllium from beryl.

University of Kansas, Engineering Experiment Station, Lawrence, Kans.
Treatment of Mississippi valley zinc ores by the electrolytic process.

University of Maine, Orono, Me.
Extraction of rare metals from their ores.

The Martin Dennis Co., 859 Summer Avenue, Newark, N. J.
Extraction of chromium as soluble salts from chrome iron ore or chromite.

Massachusetts Institute of Technology, Department of Mining and Metallurgy, 69 Massachusetts Avenue, Cambridge, Mass.
Form in which copper exists in smelter slags.
Leaching copper from reverberatory slags.
Softening lead by use of an easily fusible flux.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Chrome ore fellowship.
Aluminum fellowship.
Slag fellowship.

Metal and Thermit Corporation, 120 Broadway, New York, N. Y.
Utilization of rutile and ilmenite.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
Copper refining with special relation to arsenic.
Secondary metal reclamation.
Extraction of copper from slag.
Extraction of the rare metals from their deposits and the refining of the crude metal obtained.
Direct reduction and beneficiation of iron ores.
Leaching of copper.

Mississippi Valley Research Laboratories, Incorporated, 660 South 18th Street, St. Louis, Mo.
Extraction of Ti from minerals containing less than 10 per cent TiO_2.

Missouri School of Mines and Metallurgy, Department of Metallurgy and Ore Dressing, Rolla, Mo.
Sintering of zinc ores.
Preparation of durable anodes for extraction of zinc from sulphuric acid solutions.

Monmouth College, Department of Physics and Geology, Monmouth, Ill.
Extraction of metallurgical alumina from clays.

Montana State School of Mines, Butte, Mont.
Effect of various methods of pouring upon the formation of pipe in ingots.
Effect of impurities upon the current efficiency in the production of electrolytic zinc.

Motor City Testing Laboratory (Inc.), 4410 Elmhurst Street, Detroit, Mich.
The extraction of rare metals from their ores.
The extraction of nickel, chromium, and tungsten.
The extraction of ferrous alloys from their ores.
The production of alloys from their ores in a 1-step process.
The production of steel from ores in one step.
The production of rare metal and iron alloys.

W. Faitoute Munn, 318 White Street, Orange, N. J.
Extraction of rare earths as salts and production of rare metals by electrodeposition.

National Lead Co., Research Laboratories, 105 York Street, Brooklyn, N. Y.
Various steps in process for secondary-metal refining.

National Slag Association, 937 Leader Building, Cleveland, Ohio.
Physical and chemical properties of slags.
Properties of concretes in which slag has been used as the aggregate.
Development of a test for durability of slag products.
Development of new uses for slag.
Development and standardization of test methods for slag and its products.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Continuous smelting of zinc ores in vertical retorts.
Production of spiegel iron.

University of North Carolina, Chapel Hill, N. C.
Hydrometallurgical recovery of copper from oxidized ores and precipitation of copper from solutions.
The system copper-iron-sulphuric acid-water.

Oliver United Filters (Inc.), Federal Reserve Bank Building, San Francisco, Calif.
Dewatering of anode muds from electrolytic processes.
Dewatering of flue-dust at smelters after its collection by any method yielding wet mixtures.

Oregon State Agricultural College, School of Mines, Corvallis, Oreg.
Sublimation of mercury sulphide concentrates.

Pennsylvania Agricultural Experiment Station, State College, Pa.
The value of blast-furnace slag as a source of agricultural lime.

Lucius Pitkin (Inc.), 47 Fulton Street, New York, N. Y.
Extraction of beryllium.

Rare Metals Corporation, Naturita, Colo.
Recovery of radium from vanadium extraction processes.
Extraction of vanadium oxide from uranium-vanadium ores of southwestern Colorado.
Extraction of uranium compounds from vanadium extraction slimes from carnotite ore.

Rensselaer Polytechnic Institute, Troy, New York.
Physical-chemical studies of methods for separation of zinc and cadmium.
Recovery of zinc from pickling liquors.
Improvements in metallurgical practice in the separation of iron and copper in nickel ores.
The method of separating zinc and cadmium in the baghouse fume in lead smelters.

Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Engineering, Troy, N. Y.
The extraction of beryllium from beryl.

Allen E. Rogers Consulting Laboratory, 245 Franklin Avenue, Brooklyn, N. Y.
The recovery and purification of the element beryllium.

The S. W. Shattuck Chemical Co., 1805 South Bannock Street, Denver, Colo.
Extraction of tungsten, molybdenum, uranium, and vanadium from their ores or concentrates to give chemically pure and technical salts and acids.

South Dakota State School of Mines, Rapid City, S. Dak.
Recovery of gold from ores where it is closely associated with arsenopyrite.
The extraction of aluminum from clays, etc.

South Dakota State School of Mines, South Dakota State Mining Experiment Statio Rapid City, S. Dak.
Recovery of gold from Black Hills blue ores in which the gold is associate with a pyrite containing small amount of arsenic.

Stackpole Carbon Co., Tannery Street, St. Marys, Pa.
The reduction of metallic oxides by natural gas.

Superior Zinc Corporation, Bristol, Pa.
Treatment of zinc residues from chemical plants to produce metal or a marketable grade of zinc oxide.

Syracuse University, Department of Chemistry, Syracuse, N. Y.
Preparation of alkaline-earth metals.

Union Carbide and Carbon Research Laboratories, Incorporated, 30 East 42nd Street, New York, N. Y.
Smelting of chromium, tungsten, molybdenum, vanadium, manganese, silicon, zirconium and other semirare metals.

United States Bureau of Mines, Intermountain Experiment Station (in cooperation with the University of Utah), Salt Lake City, Utah.
Separation of impurities from zinc concentrates by volatilization.
A study of the roasting of zinc ores as a preparation for their hydrometallurgical treatment to secure maximum solubility of zinc.
A study of the forms in which lead is now being lost in smelter slags.

United States Bureau of Mines, North Central Experiment Station (in cooperation with the University of Minnesota), Minneapolis, Minn.
Kinetics of iron-ore reduction.
Mechanism of sulphur elimination in the blast furnace.
Transfer of heat from a moving gas stream to a column of irregular solids.
Nitrogen content of sponge iron and metal obtained by melting sponge iron.

United States Bureau of Mines, Pacific Experiment Station (in cooperation with the University of California), Berkeley, Calif.
Reduction of oxides of iron by methane.

United States Bureau of Mines, Rare and Precious Metals Experiment Station (in cooperation with the University of Nevada), Reno, Nev.
Continuous zinc smelting with natural gas.
Hydrometallurgy of manganese.

United States Bureau of Mines, Southwest Experiment Station (in cooperation with the University of Arizona), Tucson, Ariz.
Oxidation of copper concentrates.

United States Bureau of Standards, Washington, D. C.
Purification of the metals of the platinum group.

United States Geological Survey, Washington, D. C.
Leaching of lead and zinc sulphides from chat piles in northeastern Oklahoma.

United States Metals Refining Co., Carteret, N. J.
Elimination of antimony in refining of copper.
Production of copper of high purity (99.99+ per cent Cu).
Smelting of low-grade copper-bearing materials.
Recovery of smelter by-products.
Recovery of metals from complex ores and residues.

United Verde Copper Co., Research Department, Clarkdale, Ariz.
Recovery of zinc, cadmium, selenium, thallium, lead, sulphur, and iron from complex copper sulphide ores.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research (in cooperation with the United States Bureau of Mines), Salt Lake City, Utah.
Separation of impurities from zinc concentrates by volatilization.
Study of the roasting of zinc ores as a preparation for hydrometallurgical treatment to secure maximum solubility of zinc.

Vanderbilt University, Department of Geology, Nashville, Tenn.
Manufacture and properties of ferrophosphorus.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
The manufacture of sulphate from Tazewell County (Virginia) manganese ores.

Western Precipitation Co., 1016 West Ninth Street, Los Angeles, Calif.
The recovery of metals by means of volatilization.

University of Wisconsin, Department of Mining and Metallurgy, Madison, Wis.
The electrolytic zinc method applied to southwest Wisconsin zinc concentrates.

University of Wisconsin, Department of Mining and Metallurgy (in cooperation with Engineering Foundation), Madison, Wis.
Physical metallurgy of blast-furnace slags.

X. Steel and Alloy Steel Manufacture

University of Akron, Department of Chemistry, Akron, Ohio.
Preparation of pure Fe-Cr alloys.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.
Forging, heat-treatment, physical testing and coefficient of expansion of special steels.

American Cyanamid Co., 535 Fifth Avenue, New York, N.Y.
Case hardening and heat treatment of iron and steel.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the University of Michigan), 420 Lexington Avenue, New York, N. Y.
Scaling of steel at heat-treating temperatures.
Factors affecting short-cycle malleableizing.
Decarburization of steel in furnace atmospheres at heat-treating temperatures.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Co.), 420 Lexington Avenue, New York, N. Y.
Research on bright annealing.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation and the University of Michigan), 420 Lexington Avenue, New York, N. Y.
The application of heat to forging.

American Hammered Piston Ring Co., Box 758, Baltimore, Md.
Improvement of structure of steel.

American Society of Mechanical Engineers (in cooperation with Carnegie Institute of Technology and various industrial laboratories), 29 West 39th Street, New York, N. Y.
Possibilities and limitations of the type of bearing on the operation of rolling mills.
Forces in the cold rolling of nonferrous metals.
Roll neck forces in hot rolling alloy steels.

Cadillac Motor Car Co., Detroit, Mich.
Development of methods and materials for quickly and economically producing nitrided parts to resist wear and corrosion.

Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.
Methods of annealing chains.

Carnegie Institute of Technology (in cooperation with the American Society of Mechanical Engineers and various industrial laboratories), Schenley Park, Pittsburgh, Pa.
Possibilities and limitations of the type of bearing on the operation of rolling mills.

Carnegie Institute of Technology--Continued.
Forces in the cold rolling of nonferrous metals.
Roll neck forces in hot-rolling alloy steels.

Carnegie Institute of Technology (in cooperation with the United States Bureau of Mines and the Metallurgical Advisory Board), Schenley Park, Pittsburgh, Pa.
Physical chemistry of steel making.
Distribution of FeO between slag and metal.
Formation and identification of inclusions.
Viscosity of open-hearth slags.
Nonmetallic inclusions in the basic open hearth.
Method of determining inclusions.
Investigation of slag systems: the system FeO-MnO.
Equilibrium between carbon and iron oxide in iron.
Investigation of oxides in acid open-hearth steel.
The solubility of carbon in iron-manganese-silicon deoxidizers.

Case School of Applied Science, University Circle, Cleveland, Ohio.
The denitriding process as applied to steel.

Columbia University, School of Mines, New York, N. Y.
Reactions in open-hearth steel making.

Erie City Iron Works, Erie, Pa.
Production of ferro-alloys.

A. Finkl & Sons Co., 1326 Cortland Street, Chicago, Ill.
Production of a ferrous alloy which will give greater hardness penetration

Firestone Steel Products Co., Akron, Ohio.
Problems connected with rim rolling, drawing, and stamping of steel.

Firth-Sterling Steel Co., McKeesport, Pa.
Manufacture of tungsten and tantalum hard-metal compositions.

Four Wheel Drive Auto Co., Clintonville, Wis.
Heat treatment and physical testing of iron and steel.

Gardner-Denver Co., Rock Drill Division Laboratory, 39th Avenue and Williams Street, Denver, Colo.
Heat treatment of ferrous alloys to produce best properties for withstanding shock, vibration, and wear.

Gas Industries Co., 2813 Penn Avenue, Pittsburgh, Pa.
Application of oxygen and oxygen enriched air for the production of iron, steel and alloys.

General Electric Co., Research Laboratory, Schenectady, N. Y.
Production of special alloys, cemented carbide tools, special cutting tools, and permanent magnets.
Rolling and annealing magnetic sheets, silicon steel.
Production of a readily machineable, nonmagnetic, ferrous alloy.

Gillette Safety Razor Co., 15 West 1st Street, South Boston, Mass.
Strip steel and the manufacture of fine edges.

Harvard University, Cambridge, Mass.
Induction annealing.
Rolling with and without tension.
X-ray criteria for optimum annealing of metal castings and forgings.

Heppenstall Co., 4620 Hatfield Street, Pittsburgh, Pa.
Elimination of nonmetallic inclusions from steel.

Holy Cross College, Worcester, Mass.
Nitriding of malleable iron.

Ingersoll Steel & Disc Co., New Castle, Ind.
Methods of rolling and manufacture of high-carbon and alloy sheet steels, including high-speed steel sheets.
The manufacture of soft-center steels for plow shapes.
Production of composite steels consisting of one or more layers of low-carbon and other layers of high-carbon steel of tool-steel grade.
Production of rustless veneered sheets consisting of deep-drawing stock or high-carbon stock coated on one or both sides with a layer of rustless steel.
The manufacture of rustless steel, particularly in the form of sheets, and parts made from sheets.

International Harvester Co., 606 South Michigan Avenue, Chicago, Ill.
Various heat treatments.

Massachusetts Institute of Technology, Department of Mining and Metallurgy, 69 Massachusetts Avenue, Cambridge, Mass.
Gas hardening with ammonia gas.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Steel treatment fellowship.

Metallurgical Advisory Board (in cooperation with the Carnegie Institute of Technology and the United States Bureau of Mines), Pittsburgh, Pa.
Physical chemistry of steel making.
Distribution of FeO between slag and metal.

Metallurgical Advisory Board--Continued.
Formation and identification of inclusions.
Viscosity of open-hearth slags.
Nonmetallic inclusions in the basic open hearth.
Method of determining inclusions.
Investigation of slag systems: the system FeO-MnO.
Equilibrium between carbon and iron oxide in iron.
Investigation of oxides in acid open-hearth steel.
The solubility of carbon in iron-manganese-silicon deoxidizers.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Refinements in steel making.

University of Michigan, Department of Engineering Research (in cooperation with the American Gas Association), Ann Arbor, Mich.
Scaling of steel at heat-treating temperatures.
Factors affecting short-cycle malleableizing.
Decarburization of steel in furnace atmospheres at heat-treating temperatures.

University of Michigan, Department of Engineering Research (in cooperation with the American Gas Association and the Surface Combustion Corporation), Ann Arbor, Mich.
The application of heat to forging.

Motor City Testing Laboratory (Inc.), 4410 Elmhurst Street, Detroit, Mich.
The extraction of ferrous alloys from their ores.
The production of alloys from their ores in a 1-step process.
The production of steel from ores in one step.
The production of rare metal and iron alloys.

National Brake & Electric Co., National Steel Foundries, Belleview Place and River, Milwaukee, Wis.
Eliminating nonmetallic inclusions in acid open-hearth steel.

National District Heating Association (in cooperation with the National Tube Co.), 603 South Broadway, Greenville, Ohio.
Manufacture and utilization of pipe.

National Tube Co., Research Laboratory (in cooperation with the National District Heating Association), 4910 Forbes Street, Pittsburgh, Pa.
Manufacture and utilization of pipe.

University of Notre Dame, Notre Dame, Ind.
Carburization of steel, especially with respect to the effect of ferro-alloys mixed with the carburizer.

Ohio State University, Engineering Experiment Station, Columbus, Ohio.
A study of checker brick in the steel industry.

Pennsylvania State College, School of Mineral Industries, Department of Metallurgy, State College, Pa.
Nitriding of steel with special study of the effect of catalyzers and of nitriding agents other than ammonia.

The Peoples Gas Light & Coke Co., 122 South Michigan Avenue, Chicago, Ill.
Carburization of iron and steel by gases.

Lucius Pitkin (Inc.), 47 Fulton Street, New York, N. Y.
Heat treatment of high-speed steels in controlled atmospheres.

Pittsburgh Testing Laboratory, Pittsburgh, Pa., New York, N. Y., and elsewhere.
Deoxidizer for steel.

Rail Steel Bar Association, 228 North LaSalle Street, Chicago, Ill.
Relation of carbon to proper furnace temperatures in heating rails.
Proper rate of heating of rails.
Elimination of black spots in heating.
Survey of raw materials (rolling dates, sizes, and chemical properties of rails available for rolling).
Inspection methods for control of process.

The Reed Roller Bit Co., Box 1863, Houston, Tex.
Heat treatment of alloy steels.

W. D. Rockwell Co., 50 Church Street, New York, N. Y.
Improved methods to improve quality of heat-treated ferrous metals.

The Stanley P. Rockwell Co., 296 Homestead Avenue, Hartford, Conn.
The heat treatment of steel.

Rodman Chemical Co., Verona, Pa.
Processing and compounding for quenching oils.

Rose Polytechnic Institute, Terre Haute, Ind.
Bright annealing of stainless iron.

Stanford University, Stanford University, Calif.
Regeneration of low-carbon steels.

The Stanley Works, New Britain, Conn.
The manufacture of low-carbon open-hearth steel, higher-carbon steel, alloy, stainless and heat-resisting steels, including hot and cold rolling, and heat treatment to produce strip steel.

Surface Combustion Corporation, 2375 Dorr Street, Toledo, Ohio.
New methods of processing ferrous metals, particularly with regard to their heat treatment.

Surface Combustion Corporation (in cooperation with the American Gas Association), 2375 Dorr Street, Toledo, Ohio.
Research on bright-annealing.

Surface Combustion Corporation (in cooperation with the American Gas Association and the University of Michigan), 2375 Dorr Street, Toledo, Ohio.
The application of heat to forging.

United States Bureau of Mines (in cooperation with Carnegie Institute of Technology and the Metallurgical Advisory Board), Pittsburgh, Pa.
Physical chemistry of steel making.
Distribution of FeO between slag and metal.
Formation and identification of inclusions.
Viscosity of open-hearth slags.
Nonmetallic inclusions in the basic open hearth.
Method of determining inclusions.
Investigation of slag systems: the System FeO-MnO.
The equilibrium between carbon and iron oxide in iron.
Investigation of oxides in acid open-hearth steel.
The solubility of carbon in iron-manganese-silicon deoxidizers.

United States Bureau of Mines, North Central Experiment Station (in cooperation with the University of Minnesota), Minneapolis, Minn.
Separation of manganese, iron, and phosphorus in high-phosphorus spiegel.

United States Bureau of Standards, Washington, D. C.
Quenching media.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
Investigations of gases in steel.

Vanadium-Alloys Steel Co., Latrobe, Pa.
Cheaper methods of manufacture and new compositions of stainless irons and steels.

Victor Chemical Works, 343 South Dearborn Street, Chicago, Ill.
Utilization of ferro-phosphorus in the metal industries.

R. Wallace & Sons Manufacturing Co., Wallingford, Conn.
Pickling steel knives before tin plating.
Annealing strip steel with least possible scale.

University of Wisconsin, Department of Mining and Metallurgy, Madison, Wis.
Reactions of steel making.

Worcester Polytechnic Institute, Department of Chemistry, Worcester, Mass.
Effect of salts on pickling of iron.

Yale University, New Haven, Conn.
Influence of annealing on transformer characteristics.

XI. Nonferrous Metal and Alloy Manufacture

Aluminum Co. of America, Aluminum Research Laboratories, Box 77, New Kensington, Pa.
Metallurgy of aluminum and its alloys.

Aluminum Industries (Inc.), 2416-38 Beekman Street, Cincinnati, Ohio.
Heat treating of aluminum alloys.

The American Brass Co., Waterbury, Conn.
The improvement of the properties of copper, copper alloys, zinc alloys, and silver alloys.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation and the University of Michigan), 420 Lexington Avenue, New York, N. Y.
The application of heat to forging.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation), 420 Lexington Avenue, New York, N. Y.
Bright annealing brass and other metals.

American Hammered Piston Ring Co., Box 758, Baltimore, Md.
Improvement of structure of metals to give heat resistance, heat transfer, wear resistance, and corrosion resistance.

Belden Manufacturing Co., 4647 West Van Buren Street, Chicago, Ill.
Annealing copper wire without discoloration.

Bunting Brass and Bronze Company, Toledo, Ohio.
Work hardening and heat treating bronze alloys.

The Cleveland Graphite Bronze Co., 880 East 72nd Street, Cleveland, Ohio.
Production of nonferrous metal alloys for bearings.

Cornell University, College of Engineering, Ithaca, N. Y.
Improvement of crucible furnaces for nonferrous melting.

Fansteel Products Co. (Inc.), North Chicago, Ill.
The manufacture of the rare metals-tungsten, tantalum, molybdenum and columbium.

General Electric Co., Research Laboratory, Schenectady, N. Y.
Production of cemented carbide tools and other special alloys.

Harvard University, Cambridge, Mass.
X-ray criteria for optimum annealing of metal castings and forgings.

Harvard University, Harvard Engineering School, Cambridge, Mass.
Silver tarnishing and detarnishing.

State University of Iowa, Department of Chemistry, Iowa City, Iowa.
Preparation of alloys of barium and of strontium.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
Production of stainless silver.

University of Michigan, Department of Engineering Research (in cooperation with the American Gas Association and the Surface Combustion Corporation), Ann Arbor, Mich.
The application of heat to forging.

Montana State School of Mines, State Bureau Mines and Geology, Butte, Mont.
Age hardening of copper alloys.

Motor City Testing Laboratory (Inc.), 4410 Elmhurst Street, Detroit, Mich.
The alloying of rare metals with iron.

The J. M.Ney Co., 71 Elm Street, Hartford, Conn.
Production and fabrication of precious metal alloys for dental uses.

Pennsylvania State College, School of Mineral Industries, Department of Metallurgy, State College, Pa.
Flow of metal in the forging and extrusion of brass.

Lucius Pitkin (Inc.), 47 Fulton Street, New York, N.Y.
Preparation of die-casting alloys for pen-point material (iridium substitutes), dental alloys, improved jewelry alloys, and spectroscopically pure gold.

Rensselaer Polytechnic Institute, Troy, N. Y.
Preparation of metallic zirconium.

Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Engineering, Troy, N. Y.
Study of the relationship between cold working, annealing, and crystal size in brasses.

W. S. Rockwell Co., 50 Church Street, New York, N. Y.
Improved methods to improve quality of heat-treated nonferrous metals.

Rodman Chemical Co., Verona, Pa.
Processing and compounding for quenching oils.

Surface Combustion Corporation, 2375 Dorr Street, Toledo, Ohio.
New methods of processing nonferrous metals, particularly with regard to their heat treatment.

Surface Combustion Corporation (in cooperation with the American Gas Association), 2375 Dorr Street, Toledo, Ohio.
Bright annealing brass and other metals.

Surface Combustion Corporation (in cooperation with the American Gas Association and the University of Michigan), 2375 Dorr Street, Toledo, Ohio.
The application of heat to forging.

United States Bureau of Standards, Washington, D. C.
Quenching media.

Vanadium-Alloys Steel Co., Latrobe, Pa.
Manufacturing methods and new compositions of tungsten carbide cutting materials.

R. Wallace & Sons Manufacturing Co., Wallingford, Conn.
Nontarnishable finish for sterling silver and plated ware.
Sterling silver alloys that will not tarnish.
Soldering nickel-silver hollow handles so as not to leave pinhole effect in seams.

XII. Casting and Melting

Ajax Electric Furnace Corporation, Frankford Avenue below Girard, Philadelphia, Pa.
Electric induction methods for melting nonferrous metals.

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.
Value of gray cast iron under conditions of sliding friction.
Wearing test of chilled cast iron under conditions of impact and abrasion.

Allis-Chalmers Manufacturing Co. (in cooperation with the University of Michigan), Milwaukee, Wis.
Intermittent creep tests of 500 pounds per square inch at 850° F. for 2,000 hours on forged and cast steels.

Aluminum Industries (Inc.), 2416-38 Beekman Street, Cincinnati, Ohio.
Casting of aluminum alloys.

American Cast-Iron Pipe Co. (in cooperation with the American Society for Testing Materials), Birmingham, Ala.
Chemical analyses, transverse tests, impact tests, and hardness determinations on cast iron.

American Foundrymen's Association (in cooperation with the United States Bureau of Standards), 222 West Adams Street, Chicago, Ill.
Development of a method of measuring liquid shrinkage of cast metals.

American Gas Association (in cooperation with the American Gas Furnace Company and Mr. Robert Guthrie, consulting metallurgist), 420 Lexington Avenue, New York, N. Y.
Application of gas heat to brass melting.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the C. M. Kemp Manufacturing Company), 420 Lexington Avenue, New York, N. Y.
Development of gas immersion heating elements for galvanizing tanks.

American Gas Association, Committee on Industrial Gas Research (in cooperation with C. M. Kemp Manufacturing Co. and the Consolidated Gas Co. of New York), 420 Lexington Avenue, New York, N. Y.
Development of immersion stereotype melting equipment.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the University of Michigan), 420 Lexington Avenue, New York, N. Y.
The application of heat to core baking.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the Surface Combustion Corporation), 420 Lexington Avenue, New York, N.Y.
Brass melting, recuperator system.

American Gas Furnace Co. (in cooperation with the American Gas Association and Mr. Robert Guthrie, consulting metallurgist), Elizabeth, N. J.
Application of gas heat to brass melting.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
Correlation of properties of iron castings and test bars.

American Society for Testing Materials (in cooperation with industrial, university and government laboratories), 1315 Spruce Street, Philadelphia, Pa.
Impact tests, hardness determinations, compression tests on cast iron.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
Comprehensive study of the properties of cast irons with a view to developing irons of superior quality, especially with reference to properties at elevated temperatures.

Bond Manufacturing Corporation, Monroe and 5th Street, Wilmington, Del.
Casting or formation of tin and lead blanks for collapsible tubes.

Bunting Brass and Bronze Co., Toledo, Ohio.
Sand casting of bronze alloys.
Chill casting of bronze alloys (permanent mold and centrifugal).

Cadillac Motor Car Co., 2860 Clark Avenue, Detroit, Mich.
Cold melting, duplexing, and triplexing gray iron with electric furnaces, in the manufacture of high-strength gray iron.
Methods of manufacturing babbitted bearings and casting babbitt into backs.

Cochrane Corporation, 17th Street below Allegheny Avenue, Philadelphia, Pa.
Investigation of properties and use of good-quality grey iron.
Cast iron to resist temperatures up to 750°F.
High-strength cast iron.

Consolidated Gas Co. of New York, Laboratories (in cooperation with the American Gas Association and the C. M. Kemp Manufacturing Co.), 4 Irving Place, New York, N.Y.
Development of immersion stereotype melting equipment.

Crane Co., 836 South Michigan Avenue, Chicago, Ill.
Improvement in founding practice.

The Deister Concentrator Co., 901 Glasgow Avenue, Fort Wayne, Ind.
Recovery of metals from foundry residue and other waste materials.

The De Laval Separator Co., Poughkeepsie, N. Y.
Melting electric cast iron.
Development and casting of brass and bronze parts in electric furnace.
Development, melting, and utilization of aluminum alloys.

Detroit Steel Casting Co., 4069 Michigan Avenue, Detroit, Mich.
Various metallurgical influences on the sand casting of steel.
Controlling factors of mold actions on solidifying steel.
Heat treatment in relation to sand-cast steel structure.

Electric Steel Founders Research Group, 541 Diversey Parkway, Chicago, Ill.
Shop technique and metallurgical problems involved in the manufacture of steel castings.

Electro Refractories Corporation, 66 Andrews Building, Buffalo, N.Y.
Development of refractories (brick and cements) from magnesite, aluminum and plastic clays, for use in ferrous and nonferrous foundries.

Ford Motor Co., Dearborn, Mich.
Development of high-strength alloyed and heat-treated cast irons.
Direct casting of steel forging blanks.

Four Wheel Drive Auto Co., Clintonville, Wis.
Endurance properties of commercial malleable iron, as compared with straight-carbon cast steel.

General Motors Co. (in cooperation with the American Society for Testing Materials), Detroit, Mich.
Unnotched Charpy impact tests on cast iron.

Mr. Robert Guthrie, Consulting Metallurgist (in cooperation with the American Gas Association and the American Gas Furnace Co.), 122 South Michigan Avenue, Chicago, Ill.
Application of gas heat to brass melting.

Harvard University, Cambridge, Mass.
Influence of gases on casting refined copper.
X-ray criteria for optimum annealing of metal castings and forgings.

The Hoover Co., North Canton, Ohio.
Development of cast irons and steels with greater resistance to erosion and solution by aluminum alloys at temperatures and velocities encountered in pressure die casting.

University of Illinois (in cooperation with the American Society for Testing Materials), Urbana, Ill.
Izod impact tests and compression tests on cast iron.

The International Nickel Co. (Inc.), Development and Research Department, 67 Wall Street, New York, N. Y.
Varieties of nickel-bearing cast irons.

International Nickel Co. (in cooperation with the American Society for Testing Materials), 67 Wall Street, New York, N.Y.
Notched Charpy tests on cast iron.

C. M. Kemp Manufacturing Company (in cooperation with the American Gas Association), Baltimore, Md.
Development of gas immersion heating elements for galvanizing tanks.

C. M. Kemp Manufacturing Co. (in cooperation with the American Gas Association and the Consolidated Gas Company of New York), Baltimore, Md.
Development of immersion stereotype melting equipment.

University of Kentucky, Department of Mines and Metallurgy, Lexington, Ky.
A study of the physical effects of the addition, to aluminum, of relatively small amounts of various alloying substances, including melting procedure, heat treatment, and physical and microscopic testing in both the cast and worked conditions.

Lafayette College, Easton, Pa.
An investigation of a high tensile strength cast iron.

Lebanon Steel Foundry, Lebanon, Pa.
Corrosion, erosion, and heat resistant cast steels, for all phases of oil distillation and cracking.
Corrosion-resisting cast steels for service exposed to mine water.

Lunkenheimer Co., Beekman Street and Waverly Avenue, Cincinnati, Ohio.
Production of maximum soundness in castings.

Lunkenheimer Co. (in cooperation with the American Society for Testing Materials), Beekman Street and Waverly Avenue, Cincinnati, Ohio.
Tensile tests, shear tests, and falling-weight drop tests on cast iron.

Lynchburg Foundry Co. (in cooperation with the American Society for Testing Materials), Lynchburg, Va.
Tension tests of cast iron.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Cast iron fellowship.

University of Michigan, Ann Arbor, Mich.
X-ray examination of steel valve castings for 1,300-pound central-station service.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
The machineability of malleable cast iron.
Foundry work.
Coke pig iron.
X-ray examinations of castings.
Shrinkage of brass in melting in different furnace atmospheres.

University of Michigan (in cooperation with the Allis-Chalmers Manufacturing Co.), Ann Arbor, Mich.
Intermittent creep tests of 500 pounds per square inch at 850°F. for 2,000 hours on forged and cast steels.

University of Michigan, Department of Engineering Research (in cooperation with the American Gas Association), Ann Arbor, Mich.
The application of heat to core baking.

University of Michigan (in cooperation with the American Society for Testing Materials), Ann Arbor, Mich.
Notched Izod impact tests on cast iron.

University of Michigan, Department of Engineering Research (in cooperation with the Utilities Research Commission (Inc.)), Ann Arbor, Mich.
Brass melting by city gas.

Mississippi Valley Research Laboratory, 660 South 18th Street, St. Louis, Mo.
Development of high-strength cast iron and its alloys.

Montana State School of Mines, Butte, Mont.
Effect of various methods of pouring upon the formation of pipe in ingots.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Utilization of metallic zinc in cast form, including zinc-base alloys for die casting.

The J. M. Ney Co., 71 Elm Street, Hartford, Conn.
The use of precious metal alloys for dental purposes, including methods of casting, soldering, heat treating.

Packard Motor Car Co., Detroit, Mich.
Comparison of gray iron from the cupola and electric furnace for quality, uniformity, cost, and suitability for automotive cast iron parts.

Rensselaer Polytechnic Institute, Troy, N. Y.
Radiographic examination of castings and various structures.

Robbins and Myers (Inc.), Springfield, Ohio.
The synthesizing of high-test cast iron, including the selection of raw materials, proper amalgamation in an electric furnace, and suitable disposition of the melted metal.
Methods and means of annealing and tempering high-test cast iron.

Foster D. Snell, Consulting Chemist, 130 Clinton Street, Brooklyn, N. Y.
Improvement of molding methods for iron-foundry practice, particularly the development of molds which can be used repeatedly.

Stanford University, Department of Mining Engineering, Stanford University, Calif.
Vertical centrifugal casting of steel with controlled central cavity.

Surface Combustion Corporation (in cooperation with the American Gas Association), 2375 Dorr Street, Toledo, Ohio.
Brass melting, recuperator system.

United States Bureau of Standards, Washington, D. C.
Fluidity of cast iron.
Rubber as a foundry core binder.

United States Bureau of Standards (in cooperation with the American Society for Testing Materials), Washington, D. C.
Charpy impact tests and direct tensile impact tests on cast iron.

United States Bureau of Standards (in cooperation with the American Foundrymen's Association), Washington, D. C.
Development of a method of measuring liquid shrinkage of cast metals.

United States Pipe & Foundry Co., Burlington, N. J.
Development of high-strength cast iron.

Utilities Research Commission (Inc.) (in cooperation with the University of Michigan), 72 West Adams Street, Chicago, Ill.
Brass melting by city gas.

Walworth Alabama Co., Attalla, Ala.
Corrosion of cast iron and alloyed cast iron.
Casting strains in cast pipe of above materials.
Temperature conditions in pipe molds.
The effect of phosphorus on the strength of high-test gray iron.
Development of high-test gray iron having maximum strength.

University of Wisconsin (in cooperation with the American Society for Testing Materials), Madison, Wis.
Fatigue tests and Russell impact tests on cast iron.

XIII. Electroplating and Metallic Coating

AC Spark Plug Co., Flint, Mich.
Application of electroplating.

American Can Co., Research Department, 11th Avenue and St. Charles Road, Maywood, Ill.
The physical properties and chemical composition of tin plate.

American Chemical Paint Co., Ambler, Pa.
Application of phosphoric acid in metal protection and finishing.

American Electro-Platers Society (in cooperation with the United States Bureau of Standards), 434 South Wabash Avenue, Chicago, Ill.
Corrosion tests of plated deposits on ferrous metals.
Electroplating methods.
Rust protection and rust prevention.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the C. M. Kemp Manufacturing Co.), 420 Lexington Avenue, New York, N. Y.
Development of gas immersion heating elements for galvanizing tanks.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Tin plate, galvanized sheet and terne plate production, testing, and utilization.

American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.
Accelerated tests for protective coatings.

Barber-Colman Co., Rockford, Ill.
Improvements in methods for electroplating cadmium and zinc.

C. G. Buchanan Chemical Co., Baker Avenue, Norwood, Cincinnati, Ohio.
Cleaning parts and surfaces of copper, brass, aluminum, die castings, zinc, and other metals preparatory to electroplating, enameling, galvanizing, painting, or lacquering.

Cadillac Motor Car Co., Detroit, Mich.
Method of measuring electroplated coatings.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
Tests on metallic coatings, both dipped, sprayed, and plated for a variety of protective applications.

The De Laval Separator Co., Poughkeepsie, N. Y.
Use and recovery of tin in tinning processes.

University of Denver, University Park, Denver, Colo.
Electroplating of the rare metals.

Firestone Steel Products Co., Akron, Ohio.
Brass plating.
Cyanide zinc plating.

Firestone Tire & Rubber Co., Akron, Ohio.
Brass plating.

General Electric Co., Research Laboratory, Schenectady, N. Y.
Calorizing (coating with aluminum).

The Glidden Co., Cleveland, Ohio.
Cadmium plating.

Grasselli Chemical Co., Cleveland, Ohio.
The manufacture and use of cadmium products for electroplating.

The International Nickel Co. (Inc.), Development and Research Department, 67 Wall Street, New York, N.Y.
Nickel plating.

C. M. Kemp Manufacturing Co. (in cooperation with the American Gas Association), Baltimore, Md.
Development of gas immersion heating elements for galvanizing tanks.

Lehigh University, Department of Metallurgical Engineering, Bethlehem, Pa.
Protective values of cadmium and zinc platings against corrosion-fatigue of steel.

McGean Chemical Co., Keith Building, Cleveland, Ohio.
The electrodeposition of metals.

Marquette University, Department of Chemistry, 1217 Wisconsin Avenue, Milwaukee, Wis.
Influence of temperature, current density, composition of bath, and other variables on hardness, brightness, durability, and other properties of chromium and cadmium plating on various metals.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Protected metals fellowship.

Metals Coating Co. of America, 497 North Third Street, Philadelphia, Pa.
Corrosion protection by sprayed molten metal coatings.
Physical and chemical properties of sprayed molten metal coatings.
Applications of sprayed molten metal coatings in the arts.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Chromium plating.

W. Faitoute Munn, 318 White Street, Orange, N. J.
Extraction of rare earths from various rocks and production of their metals by means of electrodeposition.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Utilization of metallic zinc for protective coatings.

Pacific Gas & Electric Co., 4245 Hollis Street, Emeryville, Calif.
Most economical metal protective coatings for general exposure to weather.

Stanford University, Stanford University, Calif.
Grain structure and cracks in chromium plating.

Udylite Process Co., 3220 Bellevue Avenue, Detroit, Mich.
Development of the cadmium-plating process.
Development of the uses and applications of cadmium plating.

United Chromium (Inc.), 51 East 42nd Street, New York, N.Y.; Laboratories at Waterbury, Conn.
Chromium-plating processes.

United States Bureau of Standards, Washington, D. C.
Physical and mechanical properties of sprayed metal.
Theory of chromium deposition.
Protective value of chromium on steel.
Factors governing the character of deposits of silver plating.
Relative protectige value of nickel, copper, zinc, and cadmium coatings on steel.
Notch propagation in coated metals.

United States Bureau of Standards (in cooperation with the American Electro-Platers Society), Washington, D. C.
Corrosion tests of plated deposits on ferrous metals.
Electroplating methods.
Rust protection and rust prevention.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
Investigation of the effects of aging metallic brown painted surfaces on paint stability and metal protecting properties when immersed in water.

Washington University, St. Louis, Mo.
Electrodeposition of alloys.

Weisberg and Greenwald, 71 West 45th Street, New York, N. Y.
Investigations in chromium plating.
Investigations in electroplating gold-containing alloys.

Westinghouse Electric & Manufacturing Co., South Philadelphia Works, South Philadelphia, Pa.
The influence of various types and methods of chromium plating on the longevity of blades subjected to vibration.

West Virginia State Highway Department, Charleston, W. Va.
Accelerated corrosion tests on culvert pipe of concrete, cast iron, and corrugated-iron pipe with different coatings.

XIV. Welding

Air Reduction Sales Co., 100 Forrest Street, Jersey City, N. J.
Welding of and cutting of ferrous metals by oxyacetylene process.

American Chain Co. (Inc.), Bridgeport, Conn.
Influence of welding conditions and subsequent heat treatment on the structure of welds.
Weldability of carbon and alloy steels.

American Institute of Electrical Engineers (in cooperation with the Engineering Foundation and Lehigh University), 33 West 39th Street, New York, N. Y.
Utilization of pure iron electrodes for electrical welding.

American Welding Society (in cooperation with the Rensselaer Polytechnic Institute), 33 West 39th Street, New York, N.Y.
Study of structural welding.

Babcock & Wilcox Co., 85 Liberty Street, New York, N. Y.
Methods of testing welds.

Carnegie Institute of Technology, Bureau of Metallurgical Research, Schenley Park, Pittsburgh, Pa.
Metallographic studies of the welding of medium and high carbon rods.

Carnegie Institute of Technology, College of Industries, Schenley Park, Pittsburgh, Pa.
Application of welding to steam and hot-water heating systems.

Catholic University of America, Washington, D. C.
Study of locked-up stresses caused by welding heat.

Consolidated Gas Co. of New York, 4 Irving Place, New York, N. Y.
Utilization of manufactured gas for cutting and welding.

Cosma Laboratories Co., 1545 East 18th Street, Cleveland, Ohio.
The welding of nonferrous metals.

Detroit Edison Co., 2000 Second Avenue, Detroit, Mich.
Welding investigation as particularly related to Enduro tubes up to 10 inches in diameter for 1,000° F. steam.

Engineering Foundation (in cooperation with the American Institute of Electrical Engineers and Lehigh University), 29 West 39th Street, New York, N. Y.
Utilization of pure iron electrodes for electrical welding.

Fusion Welding Corporation, 103rd Street and Torrence Avenue, Chicago, Ill.
Study of fusion welding.

General Electric Co., Schenectady, N. Y.
A system for direct-current arc welding.
Influence of magnetism on the welding arc.
Classification and physical tests for various types of welded-plate joints.
Tests of metal arc welds.
The welding of ferrous and nonferrous metals by the atomic-hydrogen flame.

Harvard University, Cambridge, Mass.
The welding of rail joints, the welding of pressure vessels, and seven projects dealing with fundamentals of welding.

Independent Contact Manufacturing Co., 540 39th Street, Union City, N. J.
Development of special tungsten-molybdenum alloys for spot-welding purposes.

International Harvester Co., 606 South Michigan Avenue, Chicago, Ill.
Electric welding.

Lehigh University, Department of Metallurgy, Bethlehem, Pa.
The properties of pure gas-free iron in arc welding.

Lehigh University (in cooperation with the American Institute of Electrical Engineers and the Engineering Foundation), Bethlehem, Pa.
Utilization of pure iron electrodes for electrical welding.

Massachusetts Institute of Technology, Cambridge, Mass.
Examination of welds by the X-ray diffraction method.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Investigation and development of new methods of welding.
Study of brazed joints.
Comparative study of seamless and electrically welded tubing.

Robert Notvest, 457 South Arlington Street, Indianapolis, Ind.
Problems of resistance, electric arc and oxyacetylene welding.

Pittsburgh Testing Laboratory, Pittsburgh, Pa., New York, N. Y., and elsewhere.
Electric pipe welding.

University of Pittsburgh, Pittsburgh, Pa.
Stress distribution in fillet welds.

Purdue University (in cooperation with the Utilities Research Commission), Lafayette, Ind.
Determination of proper welding procedure for welding with manufactured (city) gas.

The Reed Roller Bit Co., Box 1863, Houston, Tex.
Surfacing of tungsten and tungsten carbide metals by welding.

Rensselaer Polytechnic Institute, Troy, N. Y.
The internal stresses produced by fillet welds made by the metallic arc.

Rensselaer Polytechnic Institute (in cooperation with the American Welding Society), Troy, N. Y.
Study of structural welding.

Rice Institute, Mechanical Engineering Department, Houston, Tex.
Friction loss across welded pipe bends.

Sperry Development Co., Manhattan Bridge Plaza, Brooklyn, N. Y.
Nondestructive tests of welds by electric-resistance method.

Stanford University, Department of Mining Engineering, Stanford University, Cal.
Welds at elevated temperatures.

The Superheater Co., 151st Street and Railroad Avenue, East Chicago, Ind.
Forge welding alloy steel.

Union Carbide and Carbon Corporation, Research Laboratory, Thompson Avenue and Manley Street, Long Island City, N. Y.
Development of methods of oxyacetylene welding of corrosion-resisting metals and alloys.
Nondestructive testing of welds by means of the stethoscope and X-ray.

United Gas Improvement Co., 3101 Passyunk Avenue, Philadelphia, Pa.
Corrosion of welded joints.

United States Bureau of Standards, Washington, D. C.
The strength of welded rail joints.
The strength of welded joints in steel tubes for use in aircraft.
Fire tests of welded steel floor construction.

United States Naval Research Laboratory, Bellevue, D. C.
Use of gamma ray for examining welds.

United States Navy, Watertown Arsenal, Watertown, N. Y.
X-ray examination of welds.

Utilities Research Commission (Inc.) (in cooperation with Purdue University), Room 522, 72 West Adams Street, Chicago, Ill.
Determination of proper welding procedure for welding with manufactured (city) gas.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Blacksburg, Va.
Properties of welded joints.

State College of Washington, Engineering Experiment Station, Pullman, Wash.
Study of welded metals under fatigue tests.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
Weld testing by measurement of magnetic potentials.
Magnetic testing of butt welds.
Fatigue tests of fillet welds to determine effect of machining, spacing, and size of weld.
Fatigue and impact tests of welds.

Yale University, New Haven, Conn.
Investigation of electrical welds in structural steel.

XV. Utilization and Development

Allen-Bradley Co., Milwaukee, Wis.
Utilization of copper, brass, aluminum, graphite, and carbon for electrical conductors.
Development of alloys of copper, silver, cadmium and nickel for electrical contacts.

Aluminum Co. of America, Aluminum Research Laboratories, Box 77, New Kensington, Pa.
Working of aluminum.
Engineering properties and applications of aluminum and its alloys.

American Electric Railway Association (in cooperation with the American Society for Testing Materials, National Electrical Manufacturers' Association, and the American Mining Congress), 292 Madison Avenue, New York, N. Y.
Development of standard design of trolley wire (350,000 c.m. size) for mine and other heavy electric-traction uses.

American Engineering Co., Aramingo Avenue and Cumberland Street, Philadelphia, Pa.
Effect of high-temperature preheated air on burning and wasting away of stoker parts.
Effect of high-temperature preheated air on expansion of stoker parts.

American Gas Association, Committee on Industrial Gas Research (in cooperation with the C. M. Kemp Manufacturing Co.), 420 Lexington Avenue, N. Y.
Materials for zinc-base, die-casting, immersion burner tubes.

American Mining Congress (in cooperation with the American Electric Railway Association, the American Society for Testing Materials, and the National Electrical Manufacturers' Association), Washington, D. C.
Development of standard design of trolley wire (350,000 c.m. size) for mine and other heavy electric-traction uses.

American Sheet & Tin Plate Co., Research Laboratory, 210 Semple Street, Pittsburgh, Pa.
Production of zinc chloride flux from zinc residues.
Production of and uses for iron sulphate and other pickling liquor by-products.

American Society of Heating and Ventilating Engineers, 4800 Forbes Street, Pittsburgh, Pa.
Application of copper tubing to steam and hot-water heating systems.

American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.
Survey of foreign and domestic design practice for the construction of pressure vessels and the performance of jacketed vessels.

American Society of Mechanical Engineers (in cooperation with Lehigh University), 29 West 39th Street, New York, N.Y.
Studies of conical spring design.

American Society of Mechanical Engineers (in cooperation with the United States Bureau of Standards and Engineering Foundation), 29 West 39th Street, New York, N. Y.
Performance and life of wire rope under various conditions of use.

American Society of Mechanical Engineers (in cooperation with various industrial laboratories), 29 West 39th Street, New York, N. Y.
Design of worm gears.

American Society for Testing Materials (in cooperation with the American Electric Railway Association, National Electrical Manufacturers' Association, and the American Mining Congress), 1315 Spruce Street, Philadelphia, Pa.
Development of standard design of trolley wire (350,000 c.m. size) for mine and other heavy electric-traction uses.

Anaconda Lead Products Co., 151st and McCook Avenue, East Chicago, Ind.
Lead compounds in storage batteries.

Automatic Electric (Inc.), 1023 West Van Buren Street, Chicago, Ill.
Treatment of Armco iron for magnetic relays.

The Babcock & Wilcox Tube Co., Beaver Falls, Pa.
Development of alloy (ferrous) tubular products.

Bailey & Sharp Co., Hamburg, N. Y.
Utilization of bismuth in glasses.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.
The study of bearing metals used at the present time, accompanied by the development of superior bearing metals for special services.
Metal roofing materials.
The suitability of various metals and alloys for the production of thin metal sheets.
Extending the use of metal foils.

Bendix Research Corporation, 401 Bendix Drive, South Bend, Ind.
Use of high resistance alloys for automotive and aeroplane work.

Bond Manufacturing Corporation, Monroe and 5th Streets, Wilmington, Del.
Extrusion of tin and lead collapsible tubes.

Brooklyn Edison Co. (Inc.), 380 Pearl Street, Brooklyn, N. Y.
Performance of alloy steel bolting materials at elevated temperatures (up to 800° F.) under field conditions with checks by laboratory studies.

C. G. Buchanan Chemical Co., Baker Avenue, Norwood, Cincinnati, Ohio.
Cleaning steel, iron, and alloy parts for repair, subsequent operations or for enameling, lacquering, painting, galvanizing, and other coating processes.

Bunting Brass & Bronze Co., Toledo, Ohio.
Development of new alloys for bearing purposes.
Substitution of bronze alloys for tin base babbitt.

Burgess Battery Co., East Main and South Brearly Streets, Madison, Wis.
Utilization of manganese dioxide ores in dry cells.

Cadillac Motor Car Co., 2860 Clark Avenue, Detroit, Mich.
Methods of manufacturing babbitted bearings and casting babbitt into backs.
Development of bearing metals, or materials, which will function without lubrication.
Development of babbitt metals which will withstand high temperature, heavy impact, extreme rubbing.

California Agricultural Experiment Station, College of Agriculture, Davis, Calif.
Comparative field and accelerated use tests of fence posts made from wood treated with various preservatives, concrete of various mixtures, reinforcing and methods of wire fastening, and steel fence posts.

California Division of Highways, Sacramento, Calif.
Study of culvert-metal performance.

The Calorizing Co., 400 Hill Street, Wilkinsburg, Pa.
Development of alloys for resistance to corrosion at elevated temperatures and high strength of materials at elevated temperatures.

Carrier Research Corporation, 750 Frelinghuysen Avenue, Newark, N. J.
A study of high-temperature solders for special applications in the zone from 400 to 1,000° F. and brazes for applications in the zone from 1,300 to 1,800° F., including physical properties, application to various metals, etc.

Cerro de Pasco Copper Corporation, 44 Wall Street, New York, N. Y.
Expansion of the uses and development of new uses for bismuth.

Continental Can Co. (Inc.), Research Department, 4633 West Grand Avenue, Chicago, Ill.
Influence of composition of solder and effect of impurities on working condition, and strength of bond produced.

The De Laval Separator Co., Poughkeepsie, N. Y.
Use of tin in tinning processes.
Reclamation and use of bearing metals and type metals.
Development, melting, and utilization of aluminum alloys.

Detroit Edison Co. (in cooperation with University of Michigan), 2000 Second Avenue, Detroit, Mich.
Metals at elevated temperatures for use in power service.

Detroit Lubricator Co., 5842 Trumbull Avenue, Detroit, Mich.
Investigation of various metals and alloys for use in the manufacture of metal bellows.

Diamond Power Specialty Corporation, 10340 Oakland Ave., Detroit, Mich.
Development of heat-resisting alloys.

Drackett Chemical Co., 5020 Spring Grove Avenue, Cincinnati, Ohio.
Fabrication of aluminum in special physical forms.

Cooper-Bessemer Corporation, Mt. Vernon, Ohio.
Study of babbitt materials and design.
Valve and valve seat materials and design for Diesel engines.

Cosma Laboratories Co., 1545 East 18th Street, Cleveland, Ohio
Development of nonpassive nickel for anodes.

Dahlstrom Metallic Door Co., Jamestown, N. Y.
Preparation of the surface of ferrous and nonferrous metals for protection and ornamental purposes.

Dardelet Threadlock Corporation, 120 Broadway, New York, N. Y.
Methods of locking screw threads.

The De Laval Separator Co., Poughkeepsie, N. Y.
Development and testing of steels for high-speed centrifuge forgings, tool steels, machine steels, and deep drawing stocks.
Testing and utilization of springs and spring steel.

The Eagle-Picher Lead Co., 134 North LaSalle Street, Chicago, Ill.
Application to customers' uses of alloys of lead, antimony and (or) tin.

Electrolux Servel Corporation, 408 East 111th Street, New York, N. Y.
Developments of alloys suitable for use with aqua ammonia in refrigeration.

Engineering Foundation (in cooperation with the American Society of Mechanical Engineers and the United States Bureau of Standards), 29 West 39th Street, New York, N. Y.
Performance and life of wire rope under various conditions of use.

Fairbanks Co., Glenwood Avenue, Binghamton, N. Y.
Use of ferrous and nonferrous metals in valves.

Falls Electric Furnace Corporation, 660 Grant Street, Buffalo, N. Y.
Uses of metals and alloys at elevated temperatures.

Fansteel Products Co. (Inc.), North Chicago, Ill.
Uses for the rare metals--tungsten, tantalum, molybdenum and columbium.

Firth-Sterling Steel Co., McKeesport, Pa.
Improvement in stainless steels.
Improvement in structure and hardening qualities of straight-carbon tool steels.
Investigation of alloy tool steels for high production purposes.

University of Florida, College of Pharmacy, Department of Chemistry, Gainesville, Fla.
Utilization of titanium and zirconium minerals.

Ford Motor Co., Dearborn, Mich.
Magnesium alloys for automotive and aircraft uses.

French Battery Co., 2317 Winnebago Street, Madison, Wis.
Manganese dioxide utilization in dry-cell manufacture.

Gardner-Denver Co., Rock Drill Division Laboratory, 39th Avenue and Williams Street, Denver, Colo.
Development of ferrous alloys to have best properties for withstanding shock, vibration, and wear.

General Electric Co., Research Laboratory, Schenectady, N. Y.
Study of cemented tungsten carbide.
Uses of tungsten, molybdenum, copper, aluminum, magnesium, and other metals.
Mercury in boilers and turbines.
Production of tungsten and molybdenum parts.

General Electric Vapor Lamp Co., 410 8th Street, Hoboken, N. J.
Utilization of mercury in gaseous electric devices for use in producing radiant energy and the conversion of alternating or direct current into electricities of other form.

General Motors Research Laboratories, General Motors Building, Detroit, Mich.
Improvement of bond between babbitt and steel backing used in bearing construction.
Development of bearing alloy with frictional quality of babbitt and possessing a high softening point.
Internal combustion engine valve steels.
Heat-resisting alloys for carburizing boxes.

The Geometric Tool Co., New Haven, Conn.
Alloys of copper and aluminum, and their machining qualities.

Georgia State Highway Department, Atlanta, Ga.
Investigation of pipe culverts.

Agricultural Experiment Station, Experiment, Ga.
Copper-lime dust compared with bordeaux mixture for disease control on varieties of tomatoes.

Grasselli Chemical Co., Cleveland, Ohio.
Improvement in catalysts of platinum or vanadium for the manufacture of sulphuric acid.
The manufacture and use of cadmium products for electroplating.
The utilization of zinc.
The metallurgy of zinc.
The metallurgy of indium.

W. and L. E. Gurley, 514 Fulton Street, Troy, N. Y.
Development of the use of strong light alloys for precision instruments where not only strength is required but also permanence of adjustment.

Handy & Harman, Bridgeport, Conn.
Development and utilization of silver solders, tarnish resisting silver alloys, and white and colored karat gold alloys.
Utilization of sterling silver.
Development of alloys for contact wire.

Harshaw Chemical Co., 1945 East 9th Street, Cleveland, Ohio.
Utilization of chromite.

Harvard University, Cambridge, Mass.
Enameling of iron and steel.

The Hoover Co., North Canton, Ohio.
Development of cast irons and steels with greater resistance to erosion and solution by aluminum alloys at temperatures and velocities encountered in pressure die casting.

Hughes Tool Co., Houston, Tex.
Development of drilling tools for rotary process in oil and gas industry.

Robert W. Hunt Co., 166 West Van Buren Street, Chicago, Ill.
Development of new alloys.

Hunt-Spiller Manufacturing Corporation, 383 Dorchester Avenue, South Boston, Mass.
The development of an iron resistant to growth under elevated temperatures, for example, stoker parts.
Development of an iron resistant to a marked degree to frictional wear and at the same time elevated temperatures.

Agricultural Experiment Station, Urbana, Ill.
Effect of feeding copper and iron salts on the copper and iron content of milk.

University of Illinois (in cooperation with the Utilities Research Commission (Inc.)), Urbana, Ill.
Breakage of rails.

Independent Contact Manufacturing Co., 540 39th Street, Union City, N. J.
Development of special tungsten-molybdenum alloys for spot-welding purposes.
Development of refractory metallic carbide compositions for tools and dies.

International Harvester Co., 606 South Michigan Avenue, Chicago, Ill.
High-temperature resistant materials.

International Lead Refining Co., 151st and McCook Avenue, East Chicago, Ill.
New outlets for bismuth.

The International Nickel Co. (Inc.), Development and Research Department, 67 Wall Street, New York, N. Y.
Forging steels of various nickel alloys for structural purposes.
Nickel-iron alloys for high-temperature service.
Studies of uses of metals of the platinum group.
Stainless nickel for cooking utensils.

Iowa State College of Agriculture and Mechanic Arts, Engineering Experiment Station (in cooperation with the Iowa State Highway Commission), Ames, Iowa.
Performance of metal pipe culverts, particularly cast-iron pipe and corrugated-metal pipe culverts.

Iowa State Highway Commission, Laboratory (in cooperation with Iowa State College), Ames, Iowa.
Performance of metal pipe culverts, particularly cast-iron pipe and corrugated-metal pipe culverts.

Johns Hopkins University, Baltimore, Md.
Preparation of metals in catalytically active forms.

C. M. Kemp Manufacturing Co. (in cooperation with the American Gas Association) Baltimore, Md.
Materials for zinc-base die casting and immersion-galvanizing burner tubes.

Lehigh University (in cooperation with the American Society of Mechanical Engineers), Bethlehem, Pa.
Studies of conical spring design.

Arthur D. Little (Inc.), 30 Charles River Road, Cambridge, Mass.
Tinned finishes for kitchen ware.

The Lunkenheimer Co., Cincinnati, Ohio.
Development of new alloys to meet conditions of corrosion, wear resistance, strength, etc., in most economical manner.

Massachusetts Agricultural College, Agricultural Experiment Station, Amherst, Mass.
Magnesium requirements of certain common crop plants.
Relation of aluminum compounds to the ill effects of certain crops when grown in rotation with tobacco.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Steel products fellowship.
Roofing fellowship.

Metals Coating Co. of America, 497 North 3d Street, Philadelphia, Pa.
Applications of sprayed molten-metal coatings in the arts.

Metals Disintegrating Co. (Inc.), Morris Avenue and Lehigh Valley Railroad, Townley, N. J.
Outlet for and method of application for the use of metal powders.

Michigan College of Mining and Technology, Houghton, Mich.
Method of preparing and testing mine-drill steel.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
New copper compounds and alloys.

University of Michigan, Department of Engineering Research, Ann Arbor, Mich.
Permeability to various gases of alloy retorts.
Barium alloys.
Studies of special steels.
Investigations of stainless steel.
Alloys used for metal-cutting tools.
Tool steels used in metal cutting.
Metals for gaskets.
Spring materials.
Heavy plates for boiler drums.

University of Michigan (in cooperation with the Detroit Edison Co.), Ann Arbor, Mich.
Metals at elevated temperatures for use in power service.

Moraine Products Co., 329 East First Street, Dayton, Ohio.
Manufacture of molded products such as porous-metal bearings, from powdered metals, and plain rolled bronze bearings.

National Electrical Manufacturers' Association (in cooperation with the American Society for Testing Materials, American Electric Railway Association, and American Mining Congress), 420 Lexington Avenue, New York, N. Y.
Development of standard design of trolley wire (350,000 c.m. size) for mine and other heavy electric traction uses.

National Research Council, Highway Research Board, 2101 B Street, N. W., Washington, D. C.
Use of rail-steel reinforcement in highway construction.

National Slag Association, 937 Leader Building, Cleveland, Ohio.
Development of new uses for slag.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Utilization of spiegel iron.
Utilization of metallic zinc in cast form including zinc base alloys for die casting.
Utilization of metallic zinc for protective coatings.
Utilization of metallic zinc in rolled form.

The J. M. Ney Co., 71 Elm Street, Hartford, Conn.
The use of precious metal alloys for dental purposes, including methods of casting, soldering, heat treating.

North Dakota Agricultural Experiment Station, State College Station, Fargo, N. Dak.
Use of mercury and copper compounds in control of surface borne diseases of seeds, including potatoes.

Northwestern University, Evanston, Illinois.
Use of compression steel in reinforced-concrete beams.

Pennsylvania Water & Power Co., Lexington Street Building, Baltimore, Md.
Metals to resist corrosive action of water for submerged parts of water turbine.

Pfanstiehl Chemical Co., Manufacturers Terminal, Waukegan, Ill.
Uses of the rarer metals and their alloys.

Rensselaer Polytechnic Institute, Troy, N. Y.
Improvement of spark plug alloys.

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.
The reaction of mercury to various materials in an electrical circuit, especially with reference to the effect on contacting qualities in metering circuits.

Rhode Island Agricultural Experiment Station, Kingston, R. I.
Use of manganese for plant growth.
Toxic effects of aluminum on plants.

H. H. Robertson Co., Grant Building, Pittsburgh, Pa.
Utilization of steel and its protection in buildings.

Rutgers University, The College of Agriculture, New Brunswick, N. J.
Use of insecticides and fungicides containing arsenic, copper, mercury, and derivatives.
Use of fertilizers including manganese salts, etc.

Henry Souther Engineering Co., Hartford, Conn.
Turbine-blade material.

University of Southern California, Los Angeles, Calif.
Utilization of vanadium catalyst for the oxidation of sulphur dioxide.

Spicer Manufacturing Corporation, 4100 Bennett Road, Toledo, Ohio.
Materials for propeller shafts for motor cars and similar applications.

Splitdorf Electrical Co., Newark, N. J.
Utilization of nonoxidizing contact alloys, strong light-weight alloys, and nonmagnetic hard alloys.

Stackpole Carbon Co., Tannery Street, St. Marys, Pa.
Development and perfection of nonferrous oilless bearings.
Development of copper-graphite and silver-graphite contacts.

Standard Oil Co. of Ohio, Midland Bank Building, Cleveland, Ohio.
Development of tubes and/or metals to withstand high temperatures and/or pressures.

Timken Detroit Axle Co., Detroit, Mich.
Development of bronzes for use as worm wheels in worm-drive automotive axles and industrial gear reductions.

Udylite Process Co., 3220 Bellevue Avenue, Detroit, Mich.
Development of the uses and applications of cadmium plating.

Union Carbide and Carbon Research Laboratories (Inc.), 30 East 42nd Street, New York, N. Y.
Utilization of chromium, tungsten, molybdenum, vanadium, manganese, silicon, zirconium, and other semirare metals.

United Chromium (Inc.), 51 East 42nd Street, New York, N. Y.; Laboratories at Waterbury, Conn.
Chromium-plating applications.

United States Bronze Powder Works (Inc.), Herbert Avenue, Closter, N. J.
Perfecting improved alloys for the manufacture of bronze powder.
Improving polishing process in manufacture of bronze powder.
The coloring of metallic powders by heat or dyestuffs.
The standard of bronze powders.

United States Bureau of Mines, Petroleum Field Office, San Francisco, Calif.
Hard facing metals for oil-well tools.

United States Bureau of Standards, Washington, D. C.
Investigation of about 25 commercial devices for locking the nut on the bolt and the development of tests to simulate service conditions.
Conservation of tin by use of lead-base bearing metals.
Utilization of platinum and platinum metal alloys.
Utilization of copper-base nonferrous ingot metals.
The fire resistance of sheet-metal garages.

United States Bureau of Standards (in cooperation with the American Society of Mechanical Engineers and Engineering Foundation), Washington, D. C.
Performance and life of wire rope under various conditions of use.

United States Naval Academy, Engineering Experiment Station, Annapolis, Md.
The use of aluminum foil with enclosed dead air space for heat insulating purposes.
Evaluation of gland packings and packing materials by work factor method.

Agricultural College of Utah and Experiment Station, Logan, Utah.
Treating grain with copper carbonate and copper sulphate for control of smut.

University of Utah, Salt Lake City, Utah.
Utilization of alunite as a source of potash and metallic aluminum.

Utilities Research Commission (Inc.) (in cooperation with the University of Illinois), 72 West Adams Street, Chicago, Ill.
Breakage of rails.

Vanadium-Alloys Steel Co., Latrobe, Pa.
Development of new stainless irons and steels.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Virginia Engineering Experiment Station, Blacksburg, Va.
The design of close-wound helical springs.

The Wadsworth Watch Case Co., 5th and Clay Streets, Dayton, Ky.
Fabrication of precious and base metal alloys.

Walworth Co., Statler Building, Boston, Mass.
Ferrous alloys for high pressures and temperatures and resistant to chemicals.

Western Cartridge Co., East Alton, Ill.
Use of special alloys of copper, zinc, tin, lead, and other metals for cartridges.

Western Clock Co., La Salle, Ill.
Development of proper temper and alloys of brass for new parts.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
Perfecting magnetic iron.

XVI. Safety and Health

Belden Manufacturing Co., 4647 West Van Buren Street, Chicago, Ill.
Development of the best accident-prevention methods in wire drawing.

Cherry Laboratories (Inc.), 126 West 5th Street, Kansas City, Mo.
Restoration of health from lead, mercury, and arsenic poisoning.

The New Jersey Zinc Co., 160 Front Street, New York, N. Y.
Safety and health in zinc mines and smelters.

United States Metals Refining Co., Carteret, N. J.
Elimination of causes for occupational diseases.

United States Public Health Service, Office of Industrial Hygiene and Sanitation, 16 Seventh Street, S. W., Washington, D. C.
Measurement of the lead-poisoning hazard as seen in storage-battery making, including sickness records, physical examinations of the workers, and blood determinations.
Hazards to the health of workers painting watch and clock dials with luminous paint (radium and mesothorium).
Health of workers in dusty trades.
Exposure to the dusts of silver polishing.

State College of Washington, Agricultural Experiment Station, Pullman, Wash.
Toxicity of the insecticide compounds of arsenic.

E. GENERAL

I. Occurrence, Prospecting, Mining, and Economics

University of Alabama, Arthur R. Bauder, University, Ala.
Method of locating petroleum by means of direct currents of electricity.

Apache Powder Co., Benson, Ariz.
Causes of aging of gelatin dynamites.
Eutectic mixtures of nitroglycerine and nitroglycol.
Methods to reduce noxious gases in products of explosion.
Fundamental principles underlying nitration of glycerol and other higher alcohols.

Atlas Powder Co., Wilmington, Del.
All phases in the manufacture, adaptation, and application of explosives and blasting supplies.

Atlas Powder Co., Reynolds Experimental Laboratory, Tamaqua, Pa.
Development of permissible and other types of explosives for mining, tunneling, quarrying, well-shooting, and seismographical prospecting.
Development of improved types of detonators, squibs, blasting machines, galvanometers, and all blasting accessories for both general and specialized mining, quarrying, well-shooting, and seismographical work.

University of California, Department of Mining, Berkeley, Calif.
Shock losses in ventilation ducts.

Carnegie Institution of Washington, Washington, D. C.
Development of instruments for geophysical prospecting.

Colorado School of Mines, Department of Geophysics, Golden, Colo.
Geophysical prospecting for oil and minerals: a, development of methods and instruments; b, field tests on known geologic conditions; c, tests of physical properties of minerals and rocks.

Columbia University, School of Mines, New York, N. Y.
Development of a method of studying mining problems such as mining methods and subsidence, by means of models and the application of the principle of dynamical similarity.

Georgia School of Technology, Atlanta, Ga.
Georgia economic geology.

John Simon Guggenheim Memorial Foundation, 551 Fifth Avenue, New York, N. Y.
- Critical study of political and commercial policies regarding the development of mineral resources in the light of present knowledge of the character and extent of such resources in Europe.
- Deposition of ore minerals from hot aqueous solutions at high pressures.

Harvard University, Cambridge, Mass.
- Geological work on pre-Cambrian rocks of the Black Hills of South Dakota.
- Geological work at the properties of the San Luis Mining Co. at Tayolita, Durango, Mexico.

Harvard University, Harvard Engineering School, Department of Mining Engineering, Rotch Building, Cambridge, Mass.
- Methods of correlating geological and geophysical results.
- Methods of microscopical investigation of ores.
- Rock pressures and mine support at depth.
- Principles of valuation of mining properties.
- Mine taxation: Depletion.
- Mining at depth.
- Economics of the copper industry.

Humble Oil Refining Co., Houston, Tex.
- Geophysical exploration for oil and gas deposits by gravimetric and seismic methods.
- Studies of electric and magnetic phenomena.

University of Illinois, Department of Geology, Urbana, Ill.
- Geology of areas in Illinois, Kentucky, and Canada.

University of Kentucky, Department of Physics, Lexington, Ky.
- Development and research work on an electrical and a gravitational method to locate promising structure for oil deposits.

Michigan College of Mining and Technology, Houghton, Mich.
- Geophysical methods of prospecting, including electric, seismic, magnetic, and thermal methods.
- Earth-resistivity and rock-temperature measurements.
- Magnetic permeability of rocks in fields of strength corresponding to earth's field.
- Methods of mining, timbering, and slushing.
- Absorption of high-frequency waves by various geological formations.
- Application of electrical equipment to mining.
- Sensitivity of the dip needle.
- Measurements of electrical resistivity of minerals and rocks.
- Measurements of electrical resistivity of large masses of earth and rock in place with a view to determination of geologic substructure.
- Measurements of wave transmission in soils and rocks by geophone methods.

Michigan College of Mining and Technology--Continued.
Dip-needle and magnetometer surveys.
Measurements of magnetic permeability of rocks at field strengths comparable with earth's field.

Geological Survey of Minnesota, University of Minnesota, Minneapolis, Minn.
Preparation of a geologic map of Minnesota.

Missouri School of Mines and Metallurgy, Department of Mining, Rolla, Mo.
Improvement of core-drilling methods.

Montana State School of Mines, Butte, Mont.
Correlations and mapping of belt rocks in western and northwestern Montana.
Geology of the Flathead (Hog Heaven) mining district, Lake County.
Geology along the Yellowstone trail across Montana.
Geologic map of Montana.

New Mexico School of Mines, Socorro, N. Mex.
The ore deposits of Socorro County, N. Mex., with special attention to the Magdalena district.
Mineral resources of New Mexico and their economic features.

University of Oklahoma, Department of Physics, Norman, Okla.
The magnetic susceptibilities of rocks at field intensities of 0.25 to 10 gauss.

Oregon State Agricultural College, School of Mines (in cooperation with the United States Army Engineers), Corvallis, Oreg.
Industrial survey of mineral resources of the Columbia River Basin (including Willamette River).

Oxweld Acetylene Co., Purox Divisions, 2315 East 52nd Street, Los Angeles, Calif.
Transportation and storage of liquid-oxygen explosives.

Pennsylvania State College, Department of Engineering Research, State College, Pa.
Fundamental problems in measurement of air flow.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
A general study of the economic aspects of the mining and mineral-using industries of Pennsylvania.

Pennsylvania State College, School of Mineral Industries, Department of Geology, Petroleum and Natural Gas, State College, Pa.
The Silurian system in central Pennsylvania.
The stratigraphy of the Helderberg group of Pennsylvania.
The fauna of the Shriver chert of central Pennsylvania.
Heavy residue study of the limestone of central Pennsylvania.

The Reed Roller Bit Co., Box 1863, Houston, Tex.
Drilling for prospecting and production, with special emphasis on drilling in hard formations and rock.
Investigation of special drilling tools and methods.

Rice Institute, Department of Physics, Houston, Tex.
Preparation of wires for torsion balances used in geophysical prospecting for oil.
Design of sensitive torsion balances of short period.
Theory of seismograph and propagation of seismic waves.

Syracuse University, Syracuse, N. Y.
The petrography of highly metamorphosed sediments in eastern Vermont.
The distinctive characteristics in the hornblendes of the sedimentaries and intrusives.

The Trees Oil Co., Winfield, Kans.
Geophysical investigation of oil-bearing formations.

Trojan Powder Co., Hunsicker Building, Allentown, Pa.
The efficient and safe use of explosives in mining and quarrying.

United States Bureau of Mines, Intermountain Experiment Station, Salt Lake City, Utah.
Possible aid for smaller mine and mill operators.
Aircraft for mining operations.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Safe handling and use of liquid-oxygen explosives.
Investigation of explosions due to explosives.
Inflammability of gases and vapors.
Kinetics and mechanism of gaseous explosions.
The effect of electric and magnetic fields on flame propagation.
The specific heats of gases at high temperatures by the explosion method.
Development of analytical and testing methods for mine explosives.

United States Geological Survey, Washington, D.C.
Areal and structural geological studies bearing on the distribution, character, quantity, and genesis of ore and nonmetallic deposits.
Application of local geologic conditions to the finding of ore.
Computation of production curves for mineral production in certain fields and States. Preparation of mathematical tables for use in computation of production curves.
Geothermal prospecting in mines and in core-drill holes in mining areas.
The chemistry of ore deposition, including studies of the solubility of minerals in natural waters, the alteration of minerals, chemical changes induced by pressure and temperature and other similar subjects of geochemistry.

United States Geological Survey - Continued

The genesis of oil and natural gas.

Estimation of geologic time by means of genetic relationships between the radioactive elements and correlation with geologic information.

Distribution and abundance of the chemical elements in rocks.

Chemical analysis of rocks, minerals, and other natural products.

Chemical and physical research relating to geochemical and geophysical problems.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research, Salt Lake City, Utah.

Geophysical prospecting - the relationship between electrical conductivity and the frequency of the e.m.f.

Venezuelan Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa.

Seismic wave investigations in connection with geophysical prospecting for petroleum.

Yale University, Department of Geological Sciences, New Haven, Conn.

Secondary enrichment of mineral deposits.

General problems of economic geology.

Yale University, Department of Mining and Metallurgy, 14 Mansfield Street, New Haven, Conn.

Classification and selection of mining methods.

II. Beneficiation and Transportation

Allis-Chalmers Manufacturing Co., Mining Machinery Division, Milwaukee, Wis.

Drying, grinding, roasting, concentration (including flotation), and extraction investigations, including work on oxidized ores.

American Cyanamid Co., 535 Fifth Avenue, New York, N. Y.

New flotation reagents.

Theoretical studies on the mechanism of flotation.

American Smelting & Refining Co., 120 Broadway, New York, N. Y.

Development of flotation reagents.

Ansul Chemical Co., Marinette, Wis.

Development of flotation reagents.

University of California, Department of Mining and Metallurgy, Berkeley, Calif.

Physical and chemical surface relationships applying to flotation.

The mechanical concentration and classification of minerals of closely related density.

The flow of sands, gravels, and clastic rock-materials through orifices and chutes.

Columbia University, Department of Chemistry, 116th Street and Broadway, New York, N. Y.
Reaction of organic substances at the surface of mineral crystals in flotation (for example, galena and xanthate systems).

Colorado School of Mines, Golden, Colo.
Grinding efficiencies of mills.

Deister Machine Co., 1933-2003 East Wayne Street, Fort Wayne, Ind.
Adaption of concentrating machines to needs of industry.

General Engineering Co., Salt Lake City, Utah; 50 Broad Street, New York, N.Y.
Thickening and filtering problems.

University of Idaho and Idaho Bureau of Mines and Geology, Moscow, Idaho.
Fine-grinding studies.
Secondary-crushing investigations.
Effect of chemical reagents on sedimentation rate of pure minerals.
Effect of pure minerals on hydrogen-ion concentration of water solutions of various chemicals.
Conductivity method of determining surface of crushed minerals.
Classification in relation to grinding.
Flotation investigations.

International Electric Smelter & Machine Co., 505-41 Park Row, New York, N.Y.
Electromechanical handling of ores.

James Ore Concentrator Co., 35 East Runyon Street, Newark, N. J.
Preparation and beneficiation of minerals in general.

LaMotte Chemical Products Co., McCormick Building, Baltimore, Md.
pH control in differential ore flotation processes.

Michigan College of Mining and Technology, Department of Metallurgy, Houghton, Mich.
Development of ore-dressing machinery.
Photo-electric and photochemical research in ore dressing.
Electrostatic methods of ore separation.

Minerals Separation North American Corporation, 11 Broadway, New York, N.Y.; 220 Battery Street, San Francisco, Calif.
Flotation treatment of ores.

Montana State School of Mines, Butte, Mont.
Effect of grain size on flotation as revealed by a study of synthetic ores and mill products.

Montana State School of Mines, State Bureau of Mines and Geology, Butte, Mont.
Effect of particle size on flotation.
A study of the flocculation and dispersion of pure minerals.
Application of photo-electric cells to ore dressing.

National Sand and Gravel Association, 545 Munsey Building, Washington, D.C.
Methods of preventing segregation of sizes.

Oliver United Filters (Inc.), Federal Reserve Bank Building, San Francisco, Calif.
Dewatering by filtration and drying during filtration of gravity concentrates and of flotation concentrates.

James W. Pearl, 3700 Lake Park Avenue, Chicago, Ill.
The separation of solids and fluids by the slow-spiral-flow process.

Sharples Specialty Co., 23rd and Westmoreland Streets, Philadelphia, Pa.
The use of centrifugals as clarifiers, dehydrators, separators, or classifiers.

Stanford University, Stanford University, Calif.
The study of electrical polarization in relation to flotation-concentration of ores.
The relationship of the porosity of mineral and other aggregates to angularity of grain and grain-size distribution.

Technical Sales Corporation, Research Laboratory, 79 East 130th Street, New York, N. Y.
Electrostatic separation of minerals and other materials.

United States Bureau of Mines, Intermountain Experiment Station (in cooperation with the University of Utah), Salt Lake City, Utah.
Solubility and consumption of flotation reagents.
The effect of various gases on flotation.
The effect of absorbed gases in minerals on flotation.
Preferential flotation of slimed minerals.
Study of minus 200-mesh products of elutriation in relation to flotation losses.

United States Bureau of Mines, Mississippi Valley Experiment Station (in cooperation with the Missouri School of Mines and Metallurgy), Rolla, Mo.
Laboratory investigation of ball milling.

United States Bureau of Mines, North Central Experiment Station (in cooperation with the University of Minnesota), Minneapolis, Minn.
Explosive disintegration.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research, Salt Lake City, Utah.
- Flotation fundamentals.
- Effect of grain size on differential flotation.
- Is oxidation catalysis the basis of operation of collectors for sulphide minerals?
- The crystal structure of minerals and intermediate metallurgical products as a guide to the improvement of ore dressing and metallurgical processes.
- Depressing agents in flotation.
- Effects of electrolytes on flotation.

University of Utah, Utah Engineering Experiment Station, Department of Mining and Metallurgical Research (in cooperation with the United States Bureau of Mines), Salt Lake City, Utah.
- Solubility and consumption of flotation reagents.
- The effect of various gases on flotation.
- The effect of absorbed gases in minerals on flotation.
- Preferential flotation of slimed minerals.
- Study of minus 200-mesh products of elutriation in relation to flotation losses.

Yale University, Department of Mining and Metallurgy, 14 Mansfield Street, New Haven, Conn.
- Stratification and separation of dry materials.

III. Safety and Health

American Society of Heating and Ventilating Engineers, Research Laboratory, 4800 Forbes Street, Pittsburgh, Pa.
- Heat and moisture exchange between the human body and the surrounding atmosphere.

American Society of Heating and Ventilating Engineers, Research Laboratory (in cooperation with the United States Bureau of Mines), 4800 Forbes Street, Pittsburgh, Pa.
- Development of standards of ventilation for various types of buildings, industries, and mines with a view to improving safety, health, and comfort conditions of occupants and workers.

American Society of Heating and Ventilating Engineers, Research Laboratory (in cooperation with Washington University), 4800 Forbes Street, Pittsburgh, Pa.
- Development of a method for the quantitative measurement of atmospheric dust.

American University, Graduate School, Washington, D.C.
Dust explosions in industrial plants.

Argco Laboratories (Inc.), 150 West 22nd Street, New York, N. Y.
Equipment control and safety devices utilizing vacuum and gas-filled tubes, photo-cells, and other similar devices.

Atlas Powder Co., Reynolds Experimental Laboratory, Tamaqua, Pa.
Development of explosives having minimum evolution of poisonous products of detonation and combustion for use in poorly ventilated mines and tunnels.
Development of low-freezing explosives for safety and convenience.
Development of explosives with the minimum sensitivity to shock and friction consistent with sure and positive blasting action.
Development of explosives which may be used with safety in contact with inflammable gases and dusts.
Development of safer types of and safety devices for detonators and squibs to make for the elimination of premature explosions, misfires, and hangfires.

University of California, Department of Mining, Berkeley, Calif.
Development of new instrument for measuring cooling power of an environment.

Chicago Subway Commission (in cooperation with the University of Illinois), Chicago, Ill.
Study of proposed ventilation system of new Chicago subway.

Cosma Laboratories Co., 1545 East 18th Street, Cleveland, Ohio.
Control of manhole hazards.

Harvard University, Department of Industrial Hygiene, Boston, Mass.
The elimination of dust in the use of pneumatic tools.
Permissible dustiness.
Methods of estimating and recording dustiness.
Methods of measuring the size of dust particles.
A study of the physiologic significance of the katathermometer indications in relation to comfort, efficiency, and the physiologic reactions of men at rest and at work.
Determination of the effective temperature index for low air velocities (0 to 150 feet per minute).

Harvard University, School of Public Health, Department of Industrial Hygiene, 55 Van Dyke Street, Boston, Mass.
Effects of dusts, fumes, smokes, and gases on men and animals.
Effects of temperature, humidity, and air motion on humans.

Hercules Powder Co., Wilmington, Del.
Effect of sulphur on the fume from L. F. ammonia dynamites.
Effect of wrapper on dynamite fumes.
Variation in gelatin fumes due to age of powder.

University of Illinois, Engineering Experiment Station, Department of Mechanical Engineering (in cooperation with the Chicago Subway Commission), Urbana, Ill.
Study of proposed ventilation system of new Chicago subway.

Johns Hopkins University, Department of Physiology, Baltimore, Md.
Relation of physiological reactions of humans to atmospheric conditions.
Relation of illumination and ultra-violet light to physiological reactions.

Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, Mass.
Research in air conditioning and ventilation.

Mellon Institute of Industrial Research, Thackeray Avenue and O'Hara Street, Pittsburgh, Pa.
Fellowship on air pollution.

University of Minnesota, Minneapolis, Minn.
Methods of determining dust in air.

Pennsylvania State College, School of Mineral Industries, Department of Mining, State College, Pa.
Action of screens or wire gauzes in arresting flame in a gaseous explosive mixture, with special reference to acetylene (C_2H_2) and air.

University of Pennsylvania, Department of Physiology, Philadelphia, Pa.
Effect of environmental temperature on body temperature.

Polytechnic Institute of Brooklyn, Department of Mechanical Engineering, Brooklyn, N. Y.
Effect of forced exhaust-gas dilution and methods of reducing carbon monoxide in exhaust gases.

Citizens Smoke Abatement League of St. Louis (in cooperation with Washington University), St. Louis, Mo.
Development of an instrument for the quantitative measurement of the amount of solid matter suspended in the atmosphere.

University of South Carolina, Department of Geology, Columbia, S. C.
Toxicity of gases.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
Physiological effects of dusts.
Studies in carbon monoxide pathology.
Treatment of carbon monoxide poisoning.
Health hazards from aniline and dimethyl aniline.
Physiological and pathological action of gases and vapors.
Inflammability of gases and vapors.
Kinetics and mechanism of gaseous explosions.

Washington University, St. Louis, Mo.
Investigation of the germicidal effect caused by passing atmospheric air over heated surfaces.
Factors in garage ventilation.

Washington University (in cooperation with the American Society of Heating and Ventilating Engineers), St. Louis, Mo.
Development of a method for the quantitative measurement of atmospheric dust.

Washington University (in cooperation with the Citizens' Smoke Abatement League of St. Louis), St. Louis, Mo.
Development of an instrument for the quantitative measurement of the amount of solid matter suspended in the atmosphere.

IV. Miscellaneous

American Petroleum Institute (in cooperation with the United States Geological Survey), 250 Park Avenue, New York, N. Y.
The determination of the thermal conductivity of gases and its application to the precise analysis of gases.

American Society for Testing Materials (in cooperation with Columbia University), 1315 Spruce Street, Philadelphia, Pa.
Study of finely sized material.

American Society for Testing Materials (in cooperation with the New Jersey Zinc Co.), 1315 Spruce Street, Philadelphia, Pa.
Study of subsieve sizes of material.

American Society for Testing Materials (in cooperation with the United States Bureau of Public Roads), 1315 Spruce Street, Philadelphia, Pa.
Study of coarse screens.

Buffalo Forge Co., 490 Broadway, Buffalo, N. Y.
Investigation of dry and wet centrifugal scrubbers for use in boiler plants and chemical processes.

Columbia University (in cooperation with the American Society for Testing Materials), New York, N. Y.
Study of finely sized material.

Detroit Edison Co. (in cooperation with the University of Michigan), 2000 Second Street, Detroit, Mich.
Spectographic analysis of gas.

The Franklin Institute, The Bartol Research Foundation, Whittier Place, Swarthmore, Pa.
The theory of atomic structures and radiations.

University of Michigan (in cooperation with Detroit Edison Co.), Ann Arbor, Mich.
Spectographic analysis of gas.

University of Minnesota, School of Chemistry, Minneapolis, Minn.
Application of X-rays in the study of various metallurgical problems, and of pure minerals.

New Jersey Zinc Co. (in cooperation with the American Society for Testing Materials), 160 Front Street, New York, N. Y.
Study of subsieve sizes of material.

Pennsylvania State College, Department of Engineering Research, State College, Pa.
Fundamental problems in measurement of air flow.

Pennsylvania State College, School of Mineral Industries, State College, Pa.
The application of the microscope to the study of the middle and upper Ordovician of central Pennsylvania.

United States Bureau of Mines, Pacific Experiment Station (in cooperation with the University of California), Berkeley, Calif.
Specific heats of oxides and sulphides.
Heats of formation of oxides and sulphides.
Vapor pressure of oxides.

United States Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.
The specific heats of gases at high temperatures by the explosion method.

United States Bureau of Mines, Pittsburgh Experiment Station (in cooperation with Carnegie Institute of Technology), Pittsburgh, Pa.
The effect of electric and magnetic fields on flame propagation.

United States Bureau of Mines, Rare and Precious Metals Experiment Station (in cooperation with the University of Nevada), Reno, Nev.
The forces acting on dust particles in suspension.

United States Bureau of Public Roads (in cooperation with the American Society for Testing Materials), Washington, D.C.
Study of coarse screens.

United States Bureau of Standards, Washington, D.C.
Metallographic polishing technique.
Development of apparatus and critical study of reagents and procedures for gas analysis.

United States Geological Survey, Washington, D.C.
Determination of the coefficients of diffusivity of solids diffusing into each other at moderate and high temperatures.

United States Geological Survey (in cooperation with the American Petroleum Institute), Washington, D.C.
The determination of the thermal conductivity of gases and its application to the precise analysis of gases.

United States Steel Corporation, Research Laboratory, Kearny, N. J.
Measurement of high temperatures.

Wappler Electric Co. (Inc.), 162 Harris Avenue, Long Island City, N. Y.
Methods and apparatus for X-ray diffraction patterns of metals and minerals.

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DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

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GEOPHYSICAL ABSTRACTS

NO. XXXVIII

BY

FREDERICK W. LEE

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

GEOPHYSICAL ABSTRACTS[1]

No. 38

Compiled by Frederick W. Lee[2]

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1. GRAVITATIONAL METHODS

(794) EIN STATISCHER SCHWEREMESSER

(A STATICAL APPARATUS FOR GRAVITY MEASUREMENTS)

By H. Haalck

Zeitschrift für Geophysik, Braunschweig, vol. 8, No. 1/2, 1932, pp. 17-30.

In a previous article published under the title of "Ein statischer Schweremesser" (see Geophys. Abs. 23, p. 62) the author had shown that the question of the development of a statical apparatus for gravity measurements was brought very close to its solution and that therefore further experiments could be carried on with the hope of solving this problem definitely.

In this article Haalck describes the construction of an improved instrument by which practical measurements of the terrain could be made.

Contents of the article:

1. Fundamental principles for constructing apparatus for gravity measurements: (a) Dynamic methods; (b) static methods.

2. Theory of the barometric principle.

3. Methods for obtaining the necessary sensitivity.

4. Reading device.

5. Arrangement of levels and foot screws.

6. Influence of temperature changes upon the readings.

7. Elimination of the influence of temperature.

The purpose of Haalck's investigations is to develop an apparatus for gravity measurements by which the difficult and complicated methods of pendulum measurements can be replaced by quicker and simpler methods.

The article is to be continued.--W. Ayvazoglou.

(795) RECHERCHES SUR LES FILS D'ÉLINVAR

(INVESTIGATIONS ON ELINVAR WIRES)

By Boris Perebaskine

Annuaire de l'Institut de Physique du Globe, 1928.

The work described concerns investigations on elinvar wires carried out by B. Perebaskine, under the direction of M. Rothe, especially with regard to the influence of the temperature. Two wires, one 0.08 millimeter in cross-section and 66 centimeters long, and the other 0.08 millimeter in cross section and 20 centimeters long, were examined during 40 days. Temperature changes were of the order of 7° C. The equilibrium was affected only by reason of untwisting of the wire. This could certainly be avoided by careful manufacturing of the wire. The results of examinations carried out in a room heated to a temperature not over 57° C. are given in a table. The coefficient of elasticity was equal to 4.54.

The figures given in the table concern a wire of 0.08 millimeter in cross section and 66 centimeters long; they show clearly that untwisting was influenced by the time, but that during the same period of time the wire was only very little affected by temperature; the mean value of the duration of oscillations was equal to about 8 minutes and 35 seconds.

From the observations the author draws the conclusion that during a series of measurements carried out with Eötvös' torsion balance the influence of temperature can be greatly reduced if an elinvar wire of proper constitution and dimensions, similar to that examined, is used.--W. Ayvazoglou.

(796) BEITRAG ZUR THEORIE UND PRAXIS DER REFERENZPENDEL-MESSUNGEN UNTER ANWENDUNG VON MINIMUMPENDELN

(CONTRIBUTION TO THE THEORY AND PRACTICE OF REFERENCE-PENDULUM MEASUREMENTS BY USING MINIMUM PENDULUMS)

By A. Berroth

Zeitschrift für Geophysik, Braunschweig, vol. 8, No. 1/2, 1932, pp. 30-39.

In this article the author discusses the possibility of eliminating the time scale of the absolute measuring system in which, according to the old methods, the time of oscillations of a pendulum must be expressed by introducing a reference-pendulum (in practice several) which is used as a stationary pendulum and is observed simultaneously.

Theoretical principles of the reference-pendulum measurements are examined and a method showing how minimum pendulums can be used is developed.

In conclusion a numerical example is given.--W. Ayvazoglou.

(797) SCHWERE UND GEOID BEI ISOSTASIE

(GRAVITY AND GEOID IN THE ISOSTASY)

By Karl Jung

Zeitschrift für Geophysik, Braunschweig, vol. 8, No. 1/2, 1932, pp. 40-52.

Isostatic anomalies calculated in the usual way differ slightly from zero, as also does the isostatic structure of the earth's crust, because the geoid undulations are not taken into consideration in making the reduction for the level, and the relation between the surface relief and density (Pratt), respectively, and the surface relief and thickness of the earth's crust (Airy), which forms the basis for the reduction of masses, is not strictly correct owing to the convergence of the earth's radii and an irregular gravity in the earth's crust.

Spherical function developments for the geoid undulations, the free-air anomaly, and the isostatic anomaly in case of the isostatic structure of the earth's crust as determined in the usual way, are calculated, then numerical values are found up to the spherical function of the seventh order and represented in three figures.--Author's abstract translated by W. Ayvazoglou.

(798) A NEW INSTRUMENT FOR MEASURING VERY SMALL DIFFERENCE IN GRAVITY

By Kenneth Hartley

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 123-130.

Description of a new portable instrument for measuring relative values of gravity to within 2 or 3 parts in 10 million, specially designed for geophysical exploration. The principles of the design are analysed and the methods for eliminating effects of elastic hysteresis, temperature changes, variations in the barometric pressure, etc., are discussed. Also effects of initial stresses in materials, defects in alignment of locking mechanism, inaccurate leveling, etc. These difficulties are serious but seem to have been overcome. Results of preliminary field measurements near Houston, Tex., are presented and some comparison is made between the type of information given by this instrument and by the torsion balance.--Author's abstract.

(799) CHARTS FOR TORSION BALANCE READINGS

By M. M. Slotnick

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 131-133.

The calculations necessary to determine the values of the gradient and curvature quantities from the readings taken at a torsion balance station involve either slide-rule or logarithmic manipulations. The author shows here that the result obtained by writing the equations involved in linear forms of the type given in this article is well within the accuracy of the instrument.

A pair of charts can readily be made for each instrument when used in 72° azimuth settings and another pair for 120° azimuth settings. Two charts made for field use for a Bamberg instrument for the 120° of settings are appended and the equations for this particular instrument in this case are given.--W. Ayvazoglou.

(800) THE EFFECT OF HEAT TREATMENT OF FINE METALLIC SUSPENSIONS

By N. N. Zirbel

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 134-138.

When a suspended system is supported by a fine wire the equilibrium position usually changes slowly for a long time after the load is applied. The equilibrium position also changes with temperature. It is found that both of these disturbing factors can be eliminated by a suitable heat treatment of the wire. Observations have been made on tungsten and platinum-iridium wires of sizes suitable for use in the Eötvös torsion balance. Apparatus and procedure, as well as the results obtained from the experiments, are discussed.--Author's abstract.

2. MAGNETIC METHODS

(801) ÜBER REMANENTEN MAGNETISMUS VON GESTEINEN

(ON THE REMANENT MAGNETISM OF ROCKS)

By J. Koenigsberger

Gerlands Beiträge zur Geophysik, Leipzig, vol. 35, No. 2, 1932, pp. 204-216.

The question of the remanent magnetism of rocks is discussed under the following headings:

1. Relative remanence of rocks in natural conditions and after being heated in laboratorium in the earth's field: Values for a series of rocks investigated are given.

2. Causes of a relatively small remanence: The following main reasons are mentioned: (a) Displacements inside of rocks at a temperature at which, as well as below which, no magnetism worthy of notice is produced; (b) displacements in rocks at temperatures above 400°; (c) various ages of eruptive rocks; (d) oscillations and repeated heating and cooling; (e) coercive force.

3. Components of magnetization and constancy of the initial permeability: Corresponding to the constancy of the initial permeability the remanence is, in case of low field forces, proportional to them (± 3%). The vectorial resolution of the remanent magnetization into components was proved to be possible.

4. Demagnetization in the earth's field at temperatures below 585°: According to the experiments a temperature of about 500° is sufficient to produce in the earth's field a reversal magnetization.

5. Influence of the period of time of the magnetization and of the demagnetization on the remanence: It is proved by the experiments that time has influence upon the origin of the magnetization and its disappearance, as well as upon the reversal magnetization.--W. Ayvazoglou.

(802) ZUR HAALCKSCHEN THEORIE DES ERDMAGNETISMUS

(CONCERNING HAALCK'S THEORY OF EARTH MAGNETISM)

By T. Schlomka

Zeitschrift für Geophysik, Braunschweig, vol. 8, No. 1/2, 1932, pp. 84-87.

The author points out that errors have crept into Haalck's theory of earth magnetism. According to Haalck's statement the conclusion must be drawn that, based on Haalck's theory, the revolving earth produces a magnetic moment of a unit of volume which is at least 10^{14} smaller than the mean magnetization density of the earth's body necessary for the explanation of the magnetic field which is really observed.--Author's abstract translated by W. Ayvazoglou.

An explanation concerning Schlomka's statement is given by H. Haalck in his "Erwiderung" (Answer), published in the same number of the Zeitschrift für Geophysik, p. 88.--W. Ayvazoglou.

(803) MAGNETIC SURVEYS OVER MINERAL, DIABASE, AND ARTIFICIAL DYKES

By A. S. Eve and D. A. Keys

The Canadian Mining and Metallurgical Bulletin, No. 239, March, 1932, pp. 119-125.

In this paper the authors examine magnetic surveys carried out with the modern Askania types of vertical and horizontal variometers over magnetic dykes in the Sudbury region. The interpretation of the results has been confirmed by diamond drilling in some cases, and by experiments over models. Curves representing vertical and horizontal variations are given. Directions and magnitude of resultant vectors of magnetic anomalies at points above a pyrrhotite-nickel dyke and a diabase dyke, indicating overburdens of approximately 140 feet and 600 feet, respectively, are drawn.--W. Ayvazoglou.

3. SEISMIC METHODS

(804) UNITED STATES EARTHQUAKES, 1930

By Frank Newmann and R. R. Bodle

Coast and Geodetic Survey, U. S. Department of Commerce,
Washington, D.C., Serial No. 539, 1932, 26 pp.

This publication includes earthquakes of regions under the jurisdiction of the United States, though for the Hawaiian and the Philippine Islands earthquakes of volcanic origin are not included and only severe earthquakes are included for the Philippine Islands, since reports are published in Manila Earthquakes adjacent to the United States and felt within its borders or those in the regions under its jurisdiction are described, except that, in a general description only is given of Canadian earthquakes felt within the United States, as details are available in the Canadian report. The principal earthquakes of the year which were widely recorded are given regardless of location, and instrumental details for these are included.

Four illustrations showing the areas affected by shocks are given in the article.--W. Ayvazoglou.

(805) EARTHQUAKE NOTES

By R. R. Bodle

Eastern Section, Seismological Society of America,
Washington, D.C., vol. 3, No. 4, 1932, 12 pp.

The following articles are discussed in this issue:

1. The North Mississippi earthquake of December 16, 1931: The information used in compiling this preliminary report was obtained through the cooperation of postmasters, weather observers, and others. The final report on this quake will be published by the Coast and Geodetic Survey in "United States Earthquakes, 1931."

2. The Georgetown seismological observatory, by J. S. O'Connor. A description of the equipment and work of this observatory is given.

3. Mexico's first skyscraper and earthquakes: According to a recent report of the Department of Commerce, the first skyscraper in Mexico has been designed to withstand earthquake shocks with a maximum acceleration of 65 centimeters per second per second. The building is now under construction.

4. A new vertical-component seismometer: A statement concerning this new Benioff vertical seismometer which has been developed at the Seismological Laboratory in Pasadena is given. Its advantages are enumerated.

5. Other points of interest -- The advisory committee report concerns devices designed in the Seismological Laboratory, such as: (a) An automatic switching device assigned to increase the brilliancy of the recording lamps during the brief interval of greatest motion while a quake is being recorded; (b) a "wave seismometer"; (c) a "seismic frequency meter."

6. A photocell attachment for seismographs, by John P. Delaney. The photocell alarm described in this article notifies the office in case the pendulum moves off its zero position, whether from accident or an earthquake, and it also makes possible the removal of the record before the long waves and maxima have obliterated the less obvious preliminaries in the case of serious eqrthquakes.

7. University of Wisconsin -- new station.

8. Two-hundred-ton dynamite explosion. Preliminary information on the explosion carried out by the Inland Lime and Stone Co. at Manistique, Mich., is given.

9. Earthquakes and building code. The building code recommended by the National Board of Fire Underwriters (fifth edition, completely revised, 1931).

10. Navy-Princeton expedition.

11. Santiago, Cuba, earthquake of February 3, 1932.

12. Items of interest. Some items in which members of the eastern section may be interested are mentioned.

13. Epicenters. A list of epicenters determined since the last issue of the Earthquake Notes is given.--W. Ayvazoglou.

(806) BLASTING IN SEISMIC WORK

Editorial note

Engineering and Mining Journal, New York, vol. 133, No. 2, 1932, p. 77.

Methods commonly used in shot planting in commercial seismology are described. A recent innovation in shot planting, according to the Atlas Powder Co., is the use of a portable rig for drilling holes from 60 to 100 feet deep and lowering the charge in torpedo-shaped cans. These holes do not crater and can be used repeatedly, although to use them over five or six times is not recommended.

A table which may be useful in calculating the desired charge for loading a deep hole is given.--W. Ayvazoglou.

(807) UNTERSUCHUNG DER SCHALLAUSBREITUNG BEI UNTERWASSER EXPLOSIONEN

(INVESTIGATIONS OF SOUND PROPAGATION CAUSED BY UNDER-WATER EXPLOSIONS)

By W. Beuermann

Zeitschrift für Geophysik, Braunschweig, vol. 8, No. 1/2, 1932, pp. 1-16.

The headings of this article are as follows: (1) Purpose of the work; (2) apparatus; (3) place of experiments; (4) results of experiments carried out in the Baltic Sea; (5) interpretation; (6) process of the explosion; (7) experiments carried out in the laboratory; (8) gas bubble oscillations; and (9) theoretical considerations.

A translation of the author's summary reads as follows: Experiments were carried out in the Baltic Sea to determine the travel-time curves produced by underwater explosions of small charges. It was shown how the travel-times of a sound could be measured with great accuracy by using a 2-gram low-tension detonator fuse as a source of the sound and an apparatus for oscillographic registration at the receiving station. It was proved that the registered sound did not travel through the layers with higher sound velocity, as could be expected according to analogous experiments in seismics, but propagated in the water with normal velocity. Distances used for measurements were equal to 450, 2,000, and 5,000 meters; within these limits the travel-time curve was a straight line.

From the oscillograms the author determined that the detonation was not represented at the receiving station as a short and sharp sound, but that there were lasting oscillations similar to those of an echo. The duration of this echo increased with the increase of the distance. The first part of the sound curve was independent from the distance and frequencies of from 600 to 700 Hertz prevailed in this part of the curve, while in the second part of the curve the frequencies were mostly equal to 200 to 250 Hertz.

By experiments carried out in the laboratory it was proved that under the most different experimental conditions the gas bubble produced by the explosion was oscillating radially; the dependence of its oscillating frequency from the content of salt and from pressure was also measured.

A formula for the calculation of this frequency was derived empirically.--W. Ayvazoglou.

(808) SEISMISCHE UNTERSUCHUNGEN DES GEOPHYSIKALISCHEN INSTITUTES IN GÖTTINGEN

(SEISMIC INVESTIGATIONS CARRIED OUT BY THE GEOPHYSICAL INSTITUTE IN GÖTTINGEN)

By F. Gerecke, H. K. Müller, A. Ramspeck, and R. Köhler

Zeitschrift für Geophysik, Braunschweig, vol. 8, No. 1/2, 1932, pp. 65-84.

The article consists of three main parts. Part I is entitled "Measurements Carried Out on the Rhone Glacier." Preliminary information concerning this part, the purpose of which was to carry out seismic measurements of the glacier bed and to study the propagation of the seismic energy by simultaneous registration of the components of the elastic waves by means of two similarly constructed horizontal seismographs and one vertical seismograph, is given in the following two chapters:

1. The travel-time curve, by F. Gerecke. The thickness of the ice was measured by means of five longitudinal profiles and one cross profile. The results for a fixed profile, calculated according to various methods, are given in a table. The curves are shown in a diagram.

2. Azimuth and the angle of emergence of the displacement of P and S, by H. K. Müller. The following items are considered: (1) Instruments; (2) examination of the instruments; (3) direction of the shock of P_1; (4) angle of emergence of P_1; (5) angle of emergence of P_{121}; (6) periods; (7) direction of oscillation of S_1; (8) amplitudes of S_1.

Part II. Shaking table for investigating seismographs, by A. Ramspeck. A description of a shaking table constructed by Ramspeck is given. The movements of the table, as well as those of the seismograph, are registered photographically. The effect produced by the movement is examined. A schematical design of the table and diagrams showing the registrations of shocks and periodical movements are given.

Part III. A new method for examination of seismographs, by R. Köhler. The author describes a simple method of examination by which the inert mass is forced to vibrate by means of a rotating flywheel provided with an eccentric additional mass. The observed amplitudes which are drawn as functions of the period give directly the true magnified curve of the seismograph; this is proved by calculation and experiments. The method is especially useful for determining the harmful natural vibrations of a seismograph.--W. Ayvazoglou.

(809) VELOCITY OF ELASTIC WAVES IN GRANITE

By L. Don Leet and W. Maurice Ewing

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 160-173.

Items of the article:

1. Location.
2. Method.
3. Instruments.
4. Firing positions.
5. Quincy results.
6. Rockport results.
7. Westley results.
8. Average longitudinal velocity.
9. Analyses: Chemical; mineralogical.
10. Discussion: Seismic waves registered at La Courtine; comparison of laboratory and field results; relation between compressibility of granite and pressure.
11. Acknowledgments.

The velocity of elastic waves in granite was determined at Quincy and Rockport, Mass., and Westerly, R. I. The waves measured were generated by dynamite explosions. They were recorded by portable seismographs at distances ranging from 50 to 4,600 feet. The observed velocities for longitudinal waves were:

Quincy	16,260 ± 70 ft./sec.	or 4.96 ± 0.02 km./sec.[x]
Westerly	16,400 ± 120 ft./sec.	or 5.00 ± 0.04 km./sec.
Rockport	16,670 ± 40 ft./sec.	or 5.08 ± 0.01 km./sec.
Average	16,530 ± 90 ft./sec.	or 5.04 ± 0.03 km./sec.

x The ± values given in this paper are probably errors.

A three-component seismograph, used only at Quincy, recorded transverse waves, the velocity of which was 8,150 ± 90 ft./sec., or 2.48 ± 0.03 km./sec. From the two velocities determined at Quincy and the density of speciments taken from the shooting locations, 2.65 grams/cm.^{3}, values for the bulk modulus, K, compressibility, β, rigidity, μ, Poisson's ratio, σ, and Young's modulus E, were obtained as follows:

$K = 44 \pm 1 \times 10^{10}$ dynes/cm.^{2}; $\beta = 2.28 \pm 0.05 \times 10^{-12}$ cm.^{2}/dynes;
$\mu = 16.3 \pm 0.4 \times 10^{10}$ dynes/cm.^{2}; $\sigma = 0.333 \pm 0.005$;
$E = 43 \pm 1 \times 10^{10}$ dynes/cm.^{2}

The form of the time-distance curves, straight lines through the origin, indicated that the waves did not penetrate deeply. Accordingly, the values

obtained are for pressures only of a few atmospheres. The bearings of these results upon earlier investigations of the elastic constants of granite are discussed. Although direct comparisons between laboratory and field results are not conclusive, they indicate that the Adams and Williamson curve is incorrect for pressures below 2,000 megabars, and that there is no marked difference between dynamically and statically determined compressibilities of granite.--Authors' abstract.

(810) ASYMMETRY OF SOUND VELOCITY IN STRATIFIED FORMATIONS

By Burton McCollum and F. A. Snell

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 174-185.

In the course of explorations of subsurface geology by the seismograph the authors have frequently observed the pronounced effect of stratification on the velocity of seismic waves in shales, and this effect has often been utilized in practical seismography.

Recently an opportunity was afforded for securing additional quantitative data on the velocity normal to and parallel to the bedding planes. The paper points out that the velocity parallel to the planes of stratification is, in some instances, as much as 50 per cent higher than the velocity in a direction normal to the bedding planes. It is shown also that inclined stratified beds exhibit a higher apparent point-to-point velocity when sound travels in an up-dip direction than when travelling down-dip. The paper describes a procedure whereby this effect may be utilized for determining the direction and approximate magnitude of the dip in such stratified deposits. The method has proved to be of considerable practical importance where the stratified formations are obscured by overlying deposits.--Authors' abstract.

(811) THE CALCULATION OF THE MOTION OF THE GROUND FROM SEISMOGRAMS

By H. A. Wilson

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 186-199.

The equation of motion of a mechanical seismograph is $-x = y + 2ky + p^2y$, where x is the ground displacement and y the seismograph deflection. This equation may be solved for y when x is supposed known or for x when y has been observed as a function of the time. In this paper both of these ways of solving the equation are considered. The motion of the seismograph due to a train of waves starting at t = 0 is considered and also the motion due to the arrival of a single wave. In each case seismographs with several periodic times and either undamped or critically damped are considered. Curves are given showing the motion of the ground and the calculated motion of the seismograph. The motion of the ground corresponding to several simple assumed seismograms is also worked out and shown by means of curves. The

motion corresponding to a given seismogram depends greatly on the periodic time and damping of the seismograph. Finally the ground motion is deduced from two actual seismograms due to dynamite explosions. An integraph is described which enables the calculations to be done more quickly.--Author's abstract.

(812) POSSIBILITY OF FREE OSCILLATIONS OF STRATA EXCITED BY SEISMIC WAVES

By Katsutada Sezawa and Kiyoshi Kanai

Bulletin of the Earthquake Research Institute, Tokyo,
vol. 10, No. 1, 1932, pp. 1-18.

In this paper the authors are dealing with the problem of transmission of seismic waves of oscillatory type and of finite extent through strata of different elasticities, densities, and thicknesses. Conclusions on the nature of the free vibrations of strata due to seismic waves, based on mathematical discussion, are derived.--W. Ayvazoglou.

(813) NOTES ON THE WAVES IN VISCO-ELASTIC SOLID BODIES

By Katsutada Sezawa

Bulletin of the Earthquake Research Institute, Tokyo,
vol. 10, No. 1, 1932, pp. 19-22.

From the numerical examples given in this article Sezawa concludes that "It is ascertained that in the possible case of dispersion the waves are damped away during a very small fraction of a second; that is to say, they are damped in a short distance even within a fraction of the length of very short waves. Hence, it may be concluded that the waves, whose velocity is affected by the viscosity of the solid, can not be transmitted to any short distance, so that the investigation of the dispersion of waves due to its damping nature is obviously meaningless."--W. Ayvazoglou.

(814) STUDY ON THE PROPAGATION OF SEISMIC WAVES

By Hiroshi Kawasumi

Bulletin of the Earthquake Research Institute, Tokyo,
vol. 10, No. 1, 1932, pp. 94-129.

The principal aim of this paper is the examination of new methods for studying the propagation of seismic waves.

Chapter 1 deals with the determination of the velocity of P-wave, from the analysis of travel-times of the earthquake on May 21, 1928, which occurred in Chiba prefecture (selection of the method; effect of the surface crust and reduction to the level surface of the ultra-basaltic layer; numerical calculation; discussion of the results).

Chapter 2. Determination of the velocity of S-wave.

Chapter 3. Provisional calculation of time-distance curves for various hypocentral depths up to 500 kilometers.

In the appendix the author makes a reexamination of the velocity of P-wave and the accuracy of the values calculated in Chapter 3. The comparison of the results is given in tables.--W. Ayvazoglou.

(815) COMPARAISON ACCÉLÉROMÉTRIQUE DES SECOUSSES SISMIQUES DANS DEUX PARTIES DE LA VILLE DE TOKYO

(COMPARISON OF ACCELERATIONS OF SEISMIC SHOCKS IN TWO PARTS OF TOKYO)

By Mishio Ishimoto

Bulletin of the Earthquake Research Institute, Tokyo, vol. 10, No. 1, 1932, pp. 171-187.

In a previous paper (see Geophys. Abs. 34, p. 362) the author had shown that the seismic shocks observed on the surface of the earth do not have the characteristics of waves generated directly at the focus of an earthquake. These primary waves excite in the superficial layer secondary waves which constitute the greatest part of the record of a seismogram. This is proved especially by the records obtained in Hongo with the acceleration seismograph.

In this article Ishimoto gives a description of his observations on seismic shocks carried out in two parts of the City of Tokyo in order to compare their characteristics. Based on the results of these observations it was established that the seismic disturbances at two places were entirely different - the period, as well as the amplitude. Thus he draws the conclusion that the primary wave is an important factor by which the changes of the phase of the shock is caused but that the period, the amplitude, and the duration of the shock is determined entirely by the conditions of the superficial layer.

Curves and seismograms are added.--W. Ayvazoglou.

(816) A PORTABLE HORIZONTAL PENDULUM SEISMOMETER

By Fuyuhiko Kishinouye

Bulletin of the Earthquake Research Institute, Tokyo, vol. 10, No. 1, 1932, pp. 188-191.

A new portable seismometer constructed by the author which is lighter than those which have been made before is described. A photograph of the seismometer equipped with a synchronous motor for driving the recording drum is given.--W. Ayvazoglou.

4. ELECTRICAL METHODS

(817) COMMUNICATION SUR LE CAROTTAGE ELECTRIQUE

(COMMUNICATIONS CONCERNING ELECTRICAL CORING)

By C. and M. Schlumberger

II-e Congres International de forage, Paris, September, 1929, pp. 1-14.

By "electrical coring" the authors designate an operation by which the nature of rocks opened by drilling can be determined inside of the untubed part of the well by means of electrical resistivity measurements. Therefore the purpose of this operation consists of geological investigation of the ground, similar to the "mechanical coring" ordinarily used.

The present communication is divided into three parts: The first deals with the resistivity of rocks in general, since these rocks are characterized by means of electrical parameters. In the second part the technique of the measurements adopted by the authors is discussed. Finally, in the third part the authors give a summary of the application of "electrical coring," as well as the results obtained from observations made in Pechelbronn, where this method was used regularly for more than one year.

Practical examples are shown in a series of diagrams of resistivity as determined for a number of boreholes.--Authors' abstract translated by W. Ayvazoglou.

(818) UNTERSUCHUNGEN ÜBER DIE ELEKTRISCHE RAUMLADUNG UND DAS ELEKTRISCHE FELD AM BODEN

(INVESTIGATIONS CONCERNING THE ELECTRIC SPACE CHARGE AND THE ELECTRIC FIELD ON THE GROUND

By Irmgard Hahnfeld

Zeitschrift für Geophysik, Braunschweig, vol. 8, No. 1/2, 1932, pp. 89-106.

Contents of the article:

1. Apparatus.
2. On the inertia of the radioactive probes.
3. Results of experiments of parallel registrations of the air potential and space charge on a platform and on the field.
4. Measurements carried out with an earth-charging apparatus and with a potential-probe.

The purpose of the work consisted in investigating the relations between the electric space charge and the electric field on the ground. Photographically registered were:

1. The electric surface charge of the earth.
2. The electric space charge of the air.
2. The potential difference between the surface of the earth and one point in the air, h meters above the ground.

The translation of the author's abstract reads as follows: "An instrument for automatic registration of the earth's surface charge was constructed and parallel registrations of the air potential, space charge, and surface charge were carried out. The theory of the instrument was discussed; then, based on the potential theory, a layer of space charge on the ground was established by observations and its thickness (a few meters) was calculated. Inside of this a second layer a few decimeters thick and of ten times higher space charge density was supposed directly above the ground.--W. Ayvazoglou.

(819) SOME ASPECTS OF ELECTRICAL PROSPECTING APPLIED IN LOCATING OIL STRUCTURES

By Leo J. Peters and John Bardeen

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 103-122.

Electrical prospecting is defined as the science and the art of determining the variations of the electrical constants (resistivity, magnetic permeability, and the dielectric constant) of the earth's crust and of interpreting these variations in terms of geological structure. The most successful systems of prospecting are based on the study of resistivity variations. The basic assumption made is that in general changes of resistivity follow the bedding planes. Electrical methods of exploration may be divided into two classes: direct-current methods and alternating-current methods.

In Part II the fundamental theory of direct-current method is discussed and a typical survey is described.

Part III deals with the theory of alternating-current methods, with particular reference to the optimum frequency to be used. It is shown that in general very low frequencies are desirable. Two alternating-current surveys made by the Swedish American Prospecting Corporation are briefly described.

In the conclusion (Part IV) some of the difficulties of electrical prospecting are discussed. The depth to which investigations may be carried is limited. In the present stage of the art, it would take exceptionally favorable conditions to obtain reliable information much in excess of 2,000 feet. However, it is stated that improvements in methods of interpretation and in field technique should give electrical methods a definite field of usefulness in prospecting for oil.--Authors' abstract.

5. RADIOACTIVE METHODS

(820) NEUE FORSCHUNGEN ÜBER RADIOAKTIVITÄT

(NEW INVESTIGATIONS RELATING TO RADIOACTIVITY)

Editorial note

Petroleum Zeitschrift, Berlin, vol. 28, No. 11, 1932, p. 12.

A brief summary of a lecture delivered by Prof. O. Hahn before the "Verein Deutscher Chemiker" in March, 1932, on the results of his investigations concerning radioactivity is given. According to Hahn the extremely high sensitiveness of the new methods of measurements makes it possible to establish radiation specific for each radio element even in the case of one million millionth part of 1 gram of the substance.

Methods of investigations, especially the emanation method, were discussed.--W. Ayvazoglou.

(821) DAS WESEN DER ULTRASTRAHLUNG

(THE NATURE OF THE PENETRATING RADIATION)

By Jenö Barnothy and Magdalene Forro

Zeitschrift für Physik, Berlin, vol. 71, No. 11/12, 1931, pp. 778-791.

The purpose of this work consisted in examining the influence of the earthmagnetic field on the penetrating radiation.

From the fact of the existence or absence of this influence a conclusion can be drawn as to whether the radiation is of a corpuscular or wave nature. In order to determine this the authors investigated the intensity of distribution of cosmic radiation along the directions perpendicular to the magnetic meridians W. 50° and E. 140°. Maximum of intensity was found at 90° and 120°.

The arrangements of the investigations made according to two methods are described. The results are shown in tables and diagrams.--W. Ayvazoglou.

(822) DIE SPEZIFISCHE IONISATION DER HÖHENSTRAHLUNG

(SPECIFIC IONIZATION OF THE PENETRATING RADIATION)

By W. Kolhörster and L. Tuwim

Zeitschrift für Physik, Berlin, vol. 73, No. 1/2, 1931, pp. 130-136.

Tuwim's theory of the vertical countertube effect contains a constant N_o which is analogous to the constant J_o in the formula:

$$J = J_o V \Phi (\mu H)$$

derived for the ionization chambers. It is shown that the specific ionization of the penetrating radiation K is equal to:

$$K = J_o / N_o$$

K is calculated from experimental values obtained for J_o and N_o as being equal to 135 ions cm^{-1}, that is three times greater than in the case of the most rapid radioactive β-rays. The specific ionization K allows us to determine the lower limit for the energy of a single radiation ray to be equal to 2.10^9 e volts. This calculation is independent from any hypothetic assumption on the nature and absorption capabilities of the penetrating radiation.--Authors' abstract translated by W. Ayvazoglou.

(823) ZUR VERTEILUNG RADIOAKTIVER STOFFE IN DER FREIEN LUFT

(ON THE DISTRIBUTION OF RADIOACTIVE SUBSTANCES IN THE FREE AIR)

By J. Priebsch

Physikalische Zeitschrift, Leipzig, vol. 32, No. 16, 1931, pp. 622-629.

Based on the laws of the unregulated movement in the free air, the altitude distribution of emanations coming out from the ground, and their products of decomposition were calculated by V. F. Hess and W. Schmidt under the assumption that the interchange value does not depend on the altitude, and later by W. Schmidt under the assumption that the interchange increases with the increase of the altitude.

The very rapid decrease with the altitude calculated by taking into consideration W. Schmidt's later assumption seemed to agree with the observations of the vertical distribution of the radium emanation made by E. Schmidt in Graz, but this could not be considered decisive owing to the abnormal climatic conditions of the Graz basin. An error in Schmidt's calculations was disclosed, and a new calculation carried out for RaEm, ThEm, and ThB resulted in a considerably smaller decrease with the increase of the altitude.--W. Ayvazoglou.

6. GEOTHERMAL METHODS

(824) ON THE CORRELATION OF ISOGEOTHERMAL SURFACES WITH THE ROCK STRATA

By C. E. Van Orstrand

Physics, Menasha, Wis., vol. 2, No. 2, 1932, pp. 139-153.

Items of the article:

Regional variation of isogeothermal surfaces.
Local variations of isogeothermal surfaces.
Correction for surface topography.
Comments on the data of observation.
Causes of temperature variations.
Some general suggestions.

An instance of regional variation in Oklahoma and two cases of local variation, one at Long Beach, Calif., and the other at Salt Creek, Wyo., have been selected for consideration from a large number of geothermal surveys conducted during the past few years by the U. S. Geological Survey and the American Petroleum Institute. The causes of local and regional variations are unknown. Possible explanation such as radioactivity, proximity to crystalline rocks, and transfer of heat along the strata are given careful consideration in attempting to explain the observed relations between the strata and the isogeothermal surfaces.--Author's abstract.

(825) GEOTHERMAL GRADIENT DETERMINATIONS IN THE LAKE SUPERIOR COPPER MINES

By L. R. Ingersoll

Physics, Menasha, Wis., vol. 2, No. 3, 1932, pp. 154-159.

Contents of the article:

1. Method of temperature measurement: General procedure; thermometers; temperature readings.
2. Results: Theoretical interpretation of results.

The Michigan College of Mining and Technology, in cooperation with the Calumet and Hecla Copper Co. and the author, is carrying out a program of temperature measurements in the deep copper mines of northern Michigan, extending the previous work of Agassiz and others.

Temperatures were measured with mercury thermometers mounted in bakelite tubes, placed in drill holes in mine workings, where the rock has been freshly exposed, special attention being given the effects of drilling, blasting, and other heat-conduction considerations. Present results give

as the average gradient from the surface to 5,679 feet below (temp. 95.3° F.), 1° F. in 108.5 feet (0.0168° C./ meter). The gradient is more nearly uniform than has sometimes been supposed. A preliminary attempt has been made at calculating the previous "thermal history" of this region. Diffusivity of specimens of the rock measures 0.0075 c.g.s., and on this basis calculations of theoretical temperature-depth curves have been made for 25 different assumptions of previous temperature conditions, and compared with the actual curve. Results as yet are inconclusive but indicate that at least 30,000 years have elapsed since the last glacial epoch, a longer period than usually assumed.--Author's abstract.

(826) EARTH TEMPERATURES OF NORTH-CENTRAL TEXAS

By Virgil E. Barnes

Bulletin of the American Association of Petroleum Geologists, Tulsa, Okla., vol. 16, No. 4, 1932, pp. 413-416.

Temperature gradients, consequently isothermal surfaces, in north-central Texas are controlled by the proximity of the pre-Cambrian rocks to the surface. Unconformities probably also affect temperature gradients only inasmuch as they present angular relationships with better conducting rocks beneath poorer conducting rocks, or under exceptional conditions the reverse may be true. The present study indicates that a feasible explanation for the variation of geothermal gradients over anticlinal structure is the difference in conduction of heat by rocks.--Author's abstract.

(827) OIL-FIELD WATERS OF NORTH-CENTRAL TEXAS

By Virgil E. Barnes

Bulletin of the American Association of Petroleum Geologists, Tulsa, Okla., vol. 16, No. 4, 1932, pp. 409-411.

The mapping of geological structure in north-central Texas is only slightly facilitated by the results derived from the study of oil-field waters. However, application of facts already known can be of much value in regions which contain salt domes, or faults, where strongly saline solutions may approach the surface and intermingle with fresh or slightly saline solutions, thus producing abnormal waters for short distances from such features.--Author's abstract.

(828) MOVEMENTS IN THE EARTH'S CRUST

By J. S. Delury

Canadian Mining Journal, Gardenvale, vol. 53, No. 4, 1932, pp. 161-165.

After a brief discussion of the movements in the earth's crust caused by isostasy, the author says that there is still something missing in crustal theories.

In this article Delury makes an attempt to answer the question: What is the great force that has always been active in upsetting isostatic balance? This force is evidently great enough to distort the earth and to overcome the power of gravity. The appeal made at different times to astronomic forces, to different contractions of the earth, to a changing form of the geoid brought about by change in rate of rotation, as well as many other possible sources of energy can not, according to the author, be considered sufficiently effective distorting agents.

As heat is available from several sources within the earth the author is exploring the field offered by it for the explanation of earth distortion.

He says: An attempt is made to show that the earth's thermal condition, and its thermal condition in the past as read from geological history, are not in keeping with most conceptions of crustal mechanics, but are in keeping with the hypothesis of sheet-flow in the subcrust. Heat migrates horizontally in the earth, not by conduction, but through the medium of migrating hot material. It is considered possible that heat so carried introduces direct and indirect density effects in the outer earth, so that distortion is produced to upset the conditions of isostatic balance and to initiate in that way changes of level and consequent crustal deformation.

A brief discussion of relevant facts and theories concerning the earth and its crust, as well as an outline of crustal phenomena and structures, is given as a necessary preliminary to the development and application of the hypothesis outlined by the author.--W. Ayvazoglou.

7. UNCLASSIFIED METHODS

(829) PROSPECTION GÉOPHYSIQUE DU SOUS-SOL

(GEOPHYSICAL PROSPECTING OF THE SUBSOIL)

Editorial note

L'Écho des Mines et de la Métallurgie, Paris, vol. 60, No. 3984, 1932, p. 176.

This note mentions the following two articles on geophysical prospecting appearing in the Annales des Mines:

1. Gravimetrical prospecting of the subsoil, by M. H. Galbrun (see Geophys. Abs. No. 36).

2. Seismic prospection of the subsoil, by R. Maillet and J. Bazerque (see Geophys. Abs. No. 35).

The greater number of articles dealing with geophysical methods of prospecting appearing recently in the literature indicates, according to the author, that the importance of these methods is constantly increasing.
--W. Ayvazoglou.

(830) ECONOMIC VALUE OF GEOPHYSICS IN MINING

By C. H. Wilson

The Mining Journal, Phoenix, Arizona, vol. 15, No. 21, 1932, pp. 3-5.

The object of this paper, according to the author, is to indicate the desirability of using corrective measures against the abusive practices often common in the initial stages of a mining enterprise, and to explain the role of geophysics as such a corrective device and an aid in placing mining on a basis more on a par with other enterprises.

The information supplied by geophysical surveys makes it possible to improve the efficiency in the conduct of mining enterprises and to lower the risks involved.

In this discussion the author is chiefly concerned with the problems present in the field of metal mining, the most common being the direct location of sulphide orebodies by virtue of their generally high electrical conductivity. In addition to the direct location of mineralized zones the problems of structural geology, knowledge of which is necessary for the indirect location of mineralized zones, are examined.--W. Ayvazoglou.

(831) WHAT LIES FIVE MILES UNDER SEA?

By Miller James

The Washington Post, Sunday, April 3, 1932, pp. 7 and 13.

The author describes in this article the organization of an expedition which started recently for the West Indies to explore on a large scale the bottom of the ocean. The purpose of the expedition, which is equipped with the most modern apparatus, is to throw new light on the shape of the earth, as well as on the cause of earthquakes.

A newer type of submarine is used, which probably will make possible more satisfactory experiments some 60 to 80 feet below the surface of the sea with Dr. Meinesz' new gravity measuring device.

Prof. Field, who is in charge of the expedition, explained that the region of the Bahamas was selected as the base of operations for the cruise because this section of the world affords a special opportunity for testing conflicting theories on the building up of great mountain ranges, as well as the probable cause of earthquakes and volcanoes.

A brief explanation on how the exact depth of the ocean's floor at any given point can be measured by means of a "fathometer" is given--W. Ayvazoglou.

(832) THE COMPOSITION OF THE INTERIOR OF THE EARTH

By A. A. Bless

Proceedings of the National Academy of Sciences, Washington, D. C., vol. 17, No. 4, 1931, pp. 225-229.

The object of this paper is to present a theory explaining the high density of the interior of the earth on the basis of the ionization of the elements composing the core, as, according to the author, the iron core theory can not be considered to be very plausible; the composition of the earth must be assumed to be no different from that shown by other celestial bodies. The author concludes: "The paper here presented has for its aim not a dogmatic explanation of the density of the earth, but rather is it an effort to call attention to a new, probably more satisfactory method of attack of the problem."--W. Ayvazoglou.

(833) GEOPHYSICAL STUDIES IN ITALY

By A. Belluigi

Petroleum World, New York, vol. 3, No. 1, 1932, pp. 16-17.

The importance of a serious investigation of the zone flanking the Apennines on the side toward the Adriatic is pointed out. According to investigations on gravimetric relief with the Eötvös balance in the region of San Colombano on the Lambro, noteworthy indications of petroleum and of mineralized water were obtained. The existence of a deep gravimetric anticline with a gravimetric axis running from east to west immediately north of the northern edge of the hill of San Colombano was established. Besides the work done at San Colombano, geophysical studies have disclosed the Emilian sub-Paduan dislocation which is divided by the author into three areas of upheaval: Fontevivo, Montepelato, and Cavriago.

Magnetic characteristics have been noted at the apex of the gravimetric perturbations, and electrical investigations have given useful indications. Geophysical investigation of this buried Emilian dislocation has shown the possibility of discovering petroleum at Fontevivo.--W. Ayvazoglou.

(834) AERIAL PHOTOGRAPHY IN GEOLOGICAL AND GEOPHYSICAL WORK

By Jack Logan

The Oil Weekly, Houston, vol. 64, No. 10, 1932, pp. 17-26.

Aerial surveys are at present employed on an extensive scale by both the geological and geophysical branches of the oil business. In this article Logan gives a discussion on photographic mapping in the petroleum industry under the following headings:

1. Aiding the geologist.
2. Uses of aerial maps for geologists.
3. The aerial survey as a reconnaissance map.
4. The aerial survey as a guide map.
5. The aerial survey as a base map.
6. Making of photographs for geological study.
7. Uses of aerial surveys in geophysical work.

The aerial photographic map serves for the geophysicist working in the oil industry two principal purposes: In the first place, this map affords valuable aid in carrying out the geophysical exploration, and in the second place, the map constitutes a reliable and convenient base map for permanently recording the results of the exploration work and consequently for correlating work in different localities.

The applicability of photographic maps in connection with the torsion balance surveys and seismic investigations are examined.—W. Ayvazoglou.

8. GEOLOGY

(835) LIMITATIONS OF GROUND WATER AS AID IN DETERMINATION OF HIDDEN GEOLOGIC STRUCTURE

By E. K. Soper

Bulletin of the American Association of Petroleum Geologists, Tulsa, vol. 16, No. 4, pp. 335-360.

The main features of the water table are controlled by the topography. The usefulness of water-table data in searching for buried structure is limited, therefore, to those localities where the surface of the land is relatively flat—consequently, where there is no topographic clue to the underlying structure. Under such conditions, irregularities of the water table such as wide flat terraces, sharply defined artesian areas, or anticlinal bulges may be reliable indicators of the existence and location of buried structure. In making hydrographic contour maps, water levels on piezometric surfaces are sometimes erroneously included with the water-table levels, producing misleading results. Many small but prominent water-table irregularities are the result of local variation in porosity of the water-bearing material, whereas other similar irregularities are due to artificial causes such as intensive pumping of wells or extensive irrigation of some areas. There are large areas in California, on the Gulf coastal plain, and along the Atlantic coastal plain where carefully compiled ground-water data may prove helpful in determining hidden geologic structure when used with the proper limitations.—Author's abstract.

(836) STRUCTURAL AND COMMERCIAL OIL AND GAS POSSIBILITIES OF CENTRAL VALLEY REGION, CALIFORNIA

By Walter Stalder

Bulletin of the American Association of Petroleum Geologists, Houston, vol. 16, No. 4, 1932, pp. 361-371.

Relationship of the igneous core of the Marysville Buttes to the petroliferous Cretaceous rocks is presented. Lenticular sands, buttress sands, and structural terraces, or low anticlines, around a great bow in the sediments east of Kettleman Hills, afford favorable conditions for accumulation of oil and gas. Evidence of similar general conditions north of Wheeler Ridge is presented and discussed.--Author's abstract.

NEW BOOKS

(837) Bauer, Louis A. and Fleming, John A. Annual report of the director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. Reprinted from Year Book No. 30 for the year 1930-31, pages 281 to 370, 1 plate. Issued December 10, 1931. Contents: (1) General summary, (2) investigational and experimental work: (a) Terrestrial magnetism and electricity and cosmical relations, (b) research associates and collaborators, (c) magnetism and atomic physics, (d) experimental work in terrestrial electricity, (3) field work and reductions: (a) Land magnetic survey; (b) field-operations and cooperative surveys, (c) observatory-work, (d) ocean work, (e) instrument shop, (4) Miscellaneous activities, (5) abstracts of publications and investigations, (6) bibliography of contributions, (7) personnel.

(838) Conrad, V. and Weickmann, L. Ergebnisse der Kosmischen Physik (Results of cosmic physics), Akademische Verlagsgesellschaft, m.b.H., Leipzig. Vol. 1, 448,pp., 243 figs. Price, M. 46 (for the subscribers of the Gerlands Beiträgen, M. 40.). Contents: (1) On the problems of the aurora polaris, by Carl Störmer, (2) absorption coefficient of the penetrating radiation, b W. Kolhörster and L. Tuwim, (3) the barometer effect of the penetrating radiation, by W. Kolhörster and L. Tuwim, (4) the atmospheric ozone, by F. W. Paul Götz, (5) on the propagation of explosion waves in the earth's atmosphere, (6) new ways for the determination of the figure of the earth, by F. Hopfner, (7) on the dynamic of the forms of movement on the surface of the earth, by F. M. Exner.

(839) Jones, Dr. W. R., and Cissarz, Dr. Arnold. German-English geological terminology. Issued by Thos. Murby and Co., London. 250 pp. Price 12 s. 6 d. net. Many geologists and mining engineers will welcome this volume, as it fills a want which has hitherto remained unsatisfied.

(840) Macelwane, J. B., and Sohon, F. W. Introduction to theoretical seismology. Part II, Seismometry, by F. W. Sohon. 149 pp., $2.75. Publishers, John Wiley and Sons, 440 Fourth Ave., New York City. Contents: (1) Oscillatory motion, (2) the horizontal seismograph, (3) the vertical seismograph, (4) the recorder, (5) amplification, (6) friction, (7) galvanometric registration, (8) the onset of a new phase, (9) the tapping test, (10) appendix, miscellaneous graphical methods, identification of phases, Zeissig's method for determining epicenters, solution of spherical triangles, the stereographic projection, (11) tables, (12) index.

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3 - The first figure refers to the number of the abstract, the second to the method of prospecting as indicated in the Table of Contents, and the third to the page.

I. C. 6640

July, 1932

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

SHAFT SINKING AT THE MORTON SALT CO. MINE AT GRAND SALINE, TEXAS

BY

M. TAYLOR

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

SHAFT SINKING AT THE MORTON SALT CO. MINE AT GRAND SALINE, TEXAS[1]

By M. Taylor[2]

INTRODUCTION

This paper describes the sinking and lining of a 14 foot 6 inch finished diameter shaft down to and into the salt of a typical dome of the Gulf States region. The conditions and nature of the strata encountered divide the work into three distinct sections - that in (1) alluvial surface deposits, sunk through by open caisson methods, (2) water bearing rock, directly above the salt, and in (3) salt.

ACKNOWLEDGMENT

The writer wishes to acknowledge the cooperation of the sinking contractors, The Dravo Contracting Co. of Pittsburgh, Pa., through E. T. Gott, vice-president, in furnishing the data used in this paper.

GENERAL DISCUSSION

Grand Saline is located in Vanzandt County, Tex., about 65 miles east of Dallas. The town is served by the main line of the Texas & Pacific Railway and also by the Texas Short Line Railway. A spur track from the former line connected with the mine over a distance of approximately 1 mile, construction being completed shortly after the shaft-sinking operations were commenced. This spur transported all construction materials for this job, and when the mine was in operation became the connecting link to the main line of the T. & P. Ry. for rail shipments of salt. The contract was carried out for the Morton Salt Co. of Chicago, Ill., who for a number of years have operated a brine pumping and evaporating plant on this same dome within a mile of this new development.

GEOLOGY

Before letting the contract, the owner drilled a number of core holes to determine the extent of this deposit and the nature of the overburden. These showed that the salt was in the form of a truncated cone having a diameter of approximately 1 mile, with its top practically level and under 210 feet of cover. The sides of the dome were found to slope off at between 50° and 80° from the horizontal, and as the deepest prospecting holes continued in pure salt to 900 feet, there is evidently enough salt in this deposit to supply a mining operation for an almost unlimited number of years.

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1 - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6640."

2 - One of the consulting engineers, U. S. Bureau of Mines, and engineer, Dravo Contracting Co.

The surface deposits, of Tertiary age (lower Eocene), consist of layers of sand, clay, and shale tapering into a soft sandstone which extends to the 190-foot level. Below this is a cavernous limestone containing salt water, and the 5 feet directly above the salt is a layer of anhydrite, also honey-combed and containing water-filled cavities of large extent.

In the soft sandstone measures above the dome, the entire stratification is horizontal, but on the sides, after the first 50 feet of sand and clay which is still horizontal, the strata pitch steeply, following the line of the salt. The inference is that the strata were folded by the salt intrusion, the top eroded away, and in the ages following covered by fresh alluvial deposits. Figure 1 shows the strata encountered and also a columnar section of the shaft lining.

PREPARATION AND PLANT

The initial plant set-up centered around a stiff-legged derrick with a 45-foot boom which was used for hoisting in the hole and also for handling materials at the surface. Concrete aggregates arriving by car were unloaded by clamshell into elevated bins. From these the materials passed through measuring boxes to the 3/4-yard concrete mixer, from which by means of a 60-foot tower, the concrete was transferred through chutes to the caisson forms. When lining below the caisson, concrete was lowered in a 3/4-yard shaft bucket.

The first 28 feet of caisson section was excavated by clamshell bucket. Below this depth, mucking was carried out by hand-loading into the shaft bucket. At the surface the muck was dumped into 1½-yard side-dump cars operating on a 36-inch gage track, which extended to the dump.

Two 60-inch diameter vertical boilers burning lignite coal furnished steam for operating the derrick and the cementation pumps during the grouting period. Two electrically driven 12 by 10 inch compressors, each of 325 cubic foot capacity, supplied air for drilling, drill sharpener, and pumping.

After reaching the salt a temporary steel headframe was erected, and a 100-hp. electric hoist put in operation. Thereafter the derrick was maintained for concreting only. About this time an electric fan and ventube were also installed for shaft ventilation. Salt was loaded into railroad cars for disposal by the salt company.

SHAFT SINKING

After leveling-off the surface and erecting the steel caisson shoe, the concrete wall 4 feet thick was poured inside steel forms. Figure 2 shows the caisson shoe and reinforcing steel. These sections were 8 feet deep, so that the concrete was added in lifts of that amount as sinking proceeded. Good progress was maintained down to 53 feet 9 inches, which depth was reached four weeks after erecting the shoe. At this point, water encountered about 15 feet above cut through under the shoe, causing a cave-in on the north side which threw the caisson 5 inches out of plumb. Blocking on the low side of the shoe and the use of kickers at the surface was then resorted to, but despite this the shell continued to move out, being 15 inches out of plumb at 64 feet. The ground was then excavated outside the caisson on the high side to a depth of 30 feet and the timber kickers reset on the opposite side. By careful manipulation and by jetting with air and water through pipes embedded in the caisson walls for this purpose, the shell was brought back to within 3½ inches of plumb at 82 feet.

Below this depth there was considerable difficulty in getting any movement with the kickers in position. However, by undercutting the shoe, jetting, and loading with an extra form filled with muck, the caisson was finally landed in shale 8 inches out of plumb at a depth of 107.25 feet and was sealed. As the inside diameter of the caisson had been made

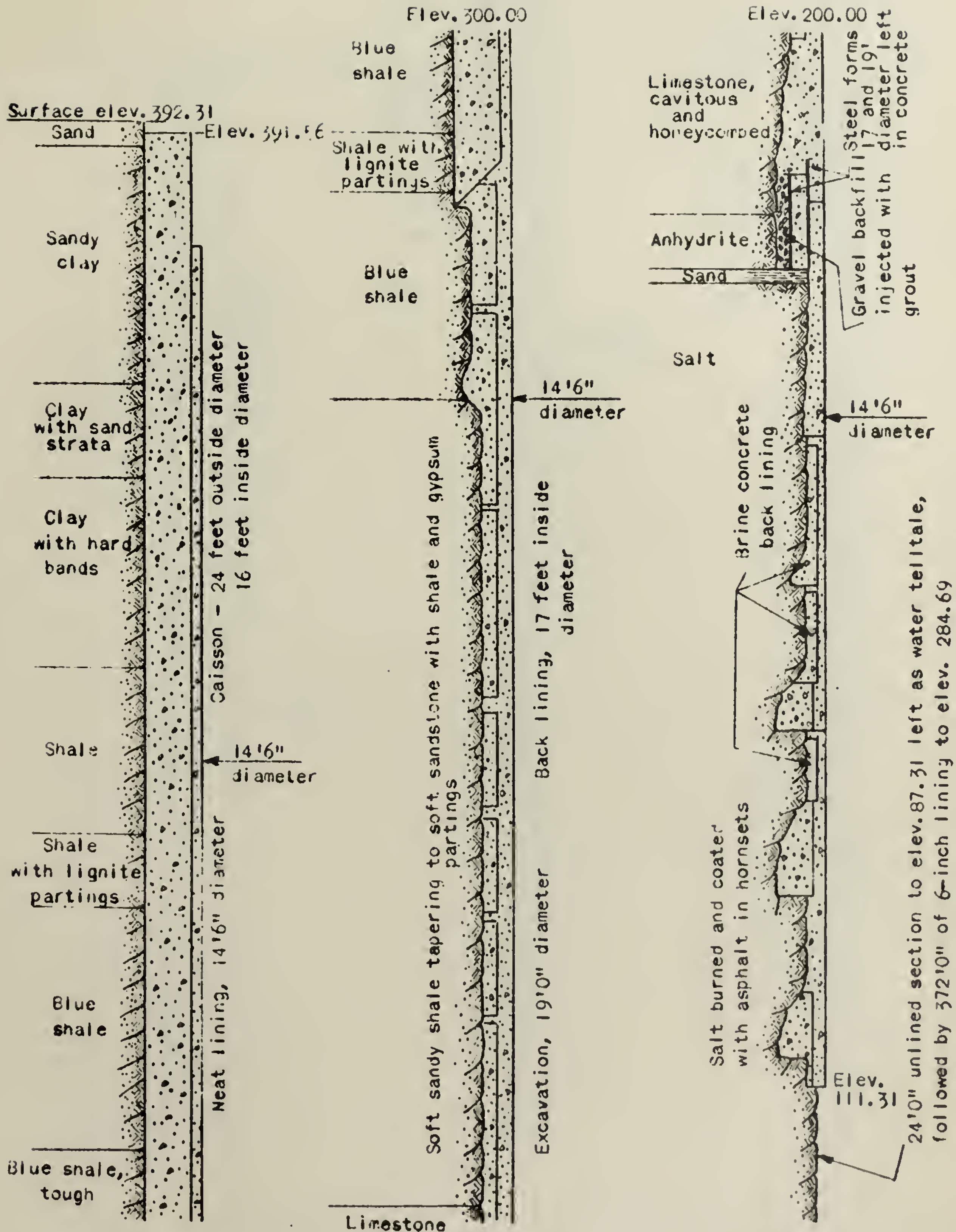

Figure 1.- Columnar section of concrete shaft lining showing strata encountered

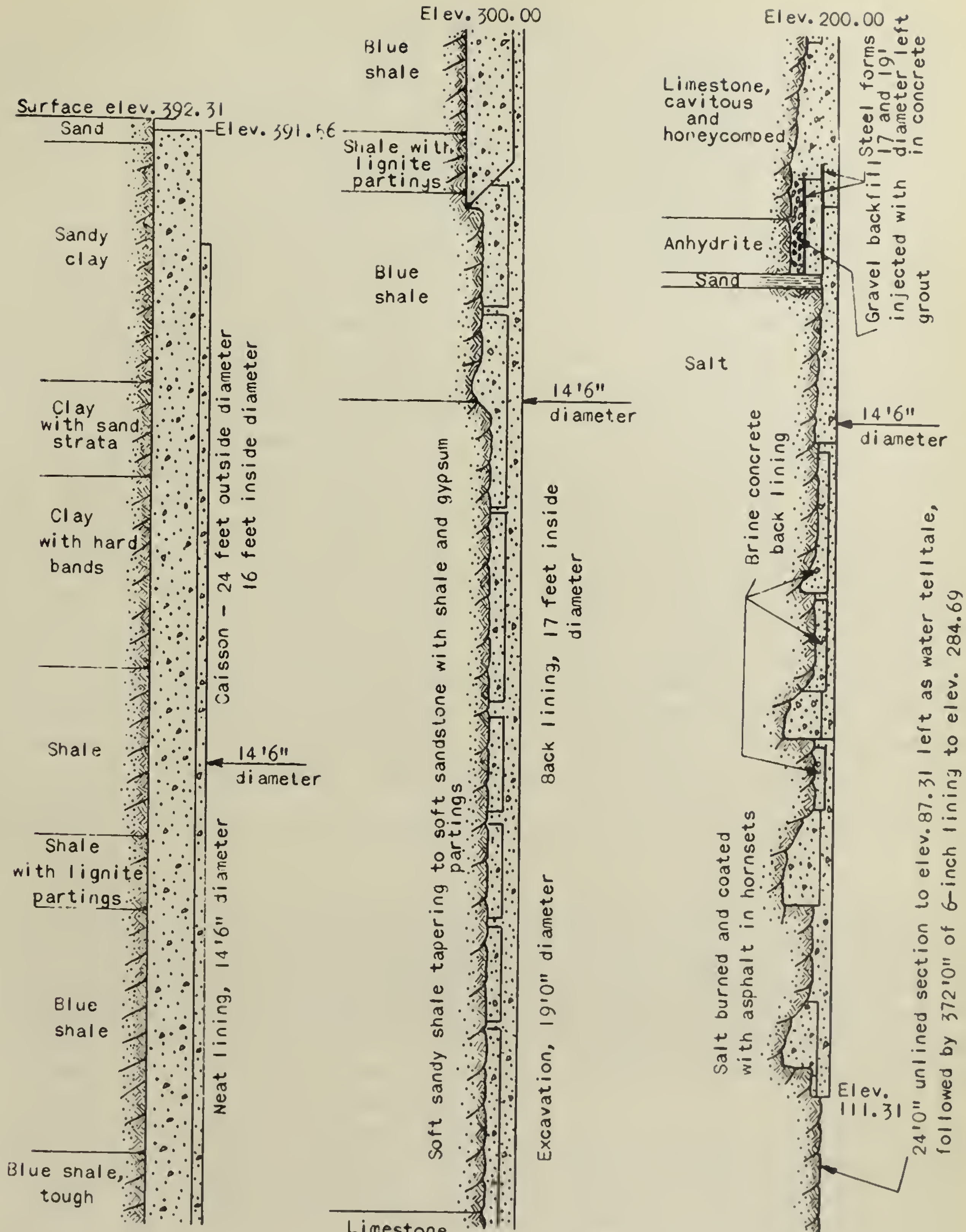

Figure 1.- Columnar section of concrete shaft lining showing strata encountered

16 feet, or 18 inches larger than the finished shaft diameter, the caisson as landed was well within the given allowance. These irregularities were later covered up by a 9 inch inner lining throughout the entire caisson section. Sinking then continued through blue shale, gradually passing into a soft sandy shale, and finally to a soft sandstone. At a depth of 157 feet 6 inches, the rock had hardened considerably and was considered strong enough to withstand grouting pressures. Consequently, grout holes were commenced from this level to penetrate the water-bearing strata below and were finally extended down to the salt at 213 feet, a total grouting length of 55 feet 6 inches. Figure 3 shows the holes for cementation of water-bearing cap rock and sand. The limestone and anhydrite cap rock were found to be very open, taking large volumes of cement; but the work went forward normally until the holes were drilled into the salt, when enormous amounts of water and fine sand under a pressure of 70 pounds per square inch came up the holes from the joint between the salt and anhydrite. Since the sand in this joint, which had an average thickness of 12 inches, could not be impregnated with grout, it was necessary to remove it on a sufficiently wide area to permit the joint to be thoroughly and completely filled with grout. To effect this, the cock on the stand-pipe was opened and the sand allowed to wash out of a hole, after which grout could be pumped in. In the later stages it was necessary to pump and spring the holes with dynamite to aid the movement of the sand before grout could be introduced. In all, five sets of grout holes from successive levels and each penetrating the sand on different diameters were projected to the salt, making a total of 131 grout holes with a total footage of 2,711 feet. Including the grout used in the rock injections, the cement consumption amounted to 8,429 bags. As stated above, the different circles of holes were drilled with the shaft bottom at successive levels, and consequently the short lengths of ground taken out between each grouting operation prevented systematic sinking which resulted in a high cost for this item. This was further aggravated by the action of the salt water on the skin of the men in the hole, causing festering and ultimately boils. Much time was lost on this account, and it became difficult to maintain a crew.

In addition to the cement used in down-hole grouting, further quantities were used as follows:

(a) With the sump at 175 feet, the pressure developed in a hole which had been drilled to the salt, cracked the weak sump, admitting huge volumes of water and sand, and finally drowned the shaft. After allowing it to fill to static level (50 feet below surface) grout was pumped down a pipe line which had its open lower end over the crack, and at the same time surface water was pumped into the shaft to create a reverse head, causing the grout to flow into the break. In this way, 1,163 bags of cement were used in effecting this seal.

(b) After penetrating the salt a small trickle of water was noticed at the top of the salt. With the resulting erosion, the flow quickly increased to an amount greatly in excess of pumping capacity and the shaft again had to be allowed to fill. The sump was then filled with gravel to a depth of 6 feet. Into this coarse aggregate 650 bags of cement were injected to form an underwater plug, which would cut off the flow. When this plug had set, the shaft was dewatered, and after further grouting from holes drilled through the plug, the leak was sealed, the plug removed, and sinking resumed.

(c) Grouting through the above plug and the final treatment of the concrete lining for the entire 213 feet of depth to the salt, consumed 1,094 bags of cement.

Drilling and Blasting

Holes were drilled by jackhammers, using cross bits dressed from 7/8 inch hollow-hexagon drill steel. In the rock section, owing to the varying nature of the formations passed through and the necessity of accommodating sinking to the grouting requirements, there was no set program for the round. Forty per cent gelatin with 1¼ by 8 inch sticks was used until the salt was entered, when, after many tests, a change was made to 30 per cent gelatin. The typical round in the salt was as shown in Figure 4. Data on drilling in salt is given in the following table:

Drilling practice in salt, using 1 by 8 inch dynamite, 264 sticks per 100 pounds

Holes	Number of holes	Depth drilled, feet	Linear feet drilled	Exploders		Dynamite, 30 per cent		
				Number used	Type	Per hole	Sticks	Pounds
Busters........	3	4	12	3	Angular	3	9	3.4
Sump................	8	9	72	8	do.	9	72	27.3
Relievers......	15	8	120	15	do.	7	105	39.8
Line or rib....	22	7	154	22	First delay	7	154	58.3
Reshooting.....	–	–	–	3	Regular	–	9	3.4
Total...........	48	–	358	51	–	–	349	132.2

Average round: 5.46 feet at 7.81 = 42.64 cubic yards (including overbreak).
Drilling per cubic yard of salt: 8.4 feet.
Drilling per pound of dynamite: 2.71 feet.
Pounds of dynamite used per cubic yard in salt: 3.10 pounds.
Number of exploders used per pound of dynamite: 0.38.

Using electric blasting caps fired from the surface, the sump round was shot out first; then while the muckers handled the broken material, the drillers continued working on the relief and line holes. Two men handled the drilling and four men the mucking. The relief and line holes were shot together by the use of regular exploders for the relief holes and first delays for the line holes. Here again drilling was carried out with cross bits and jackhammers after making trials with rotary auger drilling. While the auger cut faster than the cross bit, it was found that as the auger hole approached its full depth, the cuttings would not clear from the vertical hole, with the result that the hammer drill was given the preference.

Mucking

Below the first 28 feet of caisson excavation, which was handled by clamshell bucket, all mucking was done by hand-loading into 3/4-yard shaft buckets. In the salt where two 10-hour shifts per day were worked, each shift usually completed a round of drilling, shooting, and mucking, with the round averaging about 5½ feet and containing 43 cubic yards of material.

Pumping

While water in the rock and sand constituted the major problem, it was handled by grouting ahead of the sinking, so that apart from the breaks previously mentioned, no large flow

of water entered the shaft at any time. A No. 8 Cameron pump was employed in the shaft when passing through the water-bearing ground, and handled the water by intermittent pumping. After installing the lining and grouting behind it, there remained only local damp places.

Sinking Performance

	Caisson section, 0 to 115 feet	Rock section, 115 feet to 226 1/3 feet	Salt section, 226 1/3 feet to 677 feet
Time worked, total.....hours	808	714	938.5
Miners and bosses, total.....man-hours	6,028	4,763	6,816
Rounds, completed.....	-	26	83
Progress per round.....feet	-	4.28	5.46
Holes per round.....	-	26	48
Drilling:			
Time.....man-hours	-	799	2,266
Per man-hour.....feet	-	5.09	13.25
Per foot of advance.....do.	-	36.53	66.62
Blasting and blowing.....man-hours	-	504	1,073
Explosives per foot of advance.....pounds	-	11.36	24.21
Mucking.....man-hours	3,316	3,460	3,480
Excavation, effective.....cubic yards	1,896.4	1,304.73	3,282
Per vertical foot.....do.....	16.5	11.72	7.28
Per bucket.....do.....	-	.638	.572
Per man-hour of mucking time.....do.....	.572	.377	.943

LINING

As excavation proceeded in the soft rock below the caisson, short lengths of concrete lining were installed as shown in Figure 1. After reaching the salt, the lining to neat shaft diameter was installed through the rock section and continued up inside the caisson (fig. 5). The lining in the upper part of the salt was installed with a view to preventing any future possibility of water eroding the salt, thus creating a channel behind the lining. As shown, these precautions included the use of concrete mixed with a brine solution and the placing of three asphalt seals. Timber forms 6 feet deep with 4 segments to the circle were used for all the 14-foot 6-inch finished diameter lining, these being made and kept in repair on the job.

Concreting Performance

	Caisson and seal	Backwall, 115 to 212 feet	Neat lining, 10 feet 3 inches to 226 feet 4 inches in depth	Brine back lining in salt	Neat lining in salt
Handling forms.....man-hours	2,508	784	2,201	258	3,152
Placing reinforcing.....do.....	513	-	268	-	374.5
Concrete:					
Mixing and placing.....do.....	1,305	707	1,012	127.5	1,322
Poured.....cubic yards	1,025.2	290.5	472.35	59.1	707.25
Per foot of lining.....do.....	8.933	3.58	2.19	2.61	1.66
Total depth.....feet	114.75	81.08	216.08	22.66	426.66

Grouting Data

	Hours	Man-hours	Number of units	Units per man-hour
Down-hole grouting:				
Plant erection, repairs, etc.	66	724	-	-
Drilling:				
For 2-inch ground pipes, and placing pipes	357	2,059	1,027 feet	0.401 feet
1 7/8-inch holes	440.5	2,696	1,684 feet	.625 feet
Injecting:				
Cement	344	2,011	8,429 sacks	4.19 sacks
Chemicals	44	259	189.5 cwts.	.73 cwt.
Cleaning out holes (cement drilling)	489.5	3,042	9,877 feet	3.25 feet
Springing and blowing sand from holes	96	544	1,152 cu.ft.	2.12 cu.ft.
Other grouting:				
Sump failure at 175-foot depth	158	554	1,163 sacks	-
Under-water plug, 210 to 216 feet	25	158	650 do.	-
Behind backwall, 203 to 212 feet	8	44	321 do.	-
Behind lining	159	1,815	773 do.	-

Grouting, total hours	2,187
Grouting, total man-hours	13,906
Cement injected, total sacks	11,336

SHAFT EQUIPMENT

As Figure 5 shows, the shaft was arranged to provide an air compartment and two hoisting compartments. The bunton support castings were placed at 6 feet, vertical spacing, by attachment to the shaft forms before concreting. Therefore the time spent on these is included under concreting, in the item "Handling Forms."

	Man-hours			
	Framing	Placing	Total	Per vertical foot
Guides, 749 vertical feet	790	1,218	2,008	2.68
Buntons, 739 do.	163	1,303	1,466	1.98
Brattice, 677 do.	-	1,526	1,526	2.25

COST OF SINKING AND LINING

The following tables give the cost of sinking and lining in dollars and in man-hours for the different sections, but do not include the cost of grouting, the installation of shaft equipment, and the shaft-bottom work which carried the opening to a total depth of 739 feet from the surface; nor do they include the three asphalt seals in the salt, and the complete construction of the hornsets as shown on Figure 1. Table 1 gives the cost in dollars per foot of shaft for the three sections and Table 2 the costs in man-hours of labor.

Table 1 - Cost per vertical foot

	Caisson and seal, 0 to 115 feet				Rock section, 115 to 226.33 feet				Salt section, 226.33 to 577 feet			
	Direct labor	Permanent material	Construction material and indirect labor	Total	Direct labor	Permanent material	Construction material and indirect labor	Total	Direct labor	Permanent material	Construction material and indirect labor	Total
Drilling and blasting	-	-	-	-	$8.19	-	-	-	$5.00	-	-	-
Drills, repairs, steel, air and water lines	-	-	-	-	-	-	$10.30	-	-	-	$2.15	-
Explosives	-	-	$0.81	-	-	-	3.39	-	-	-	5.97	-
Mucking	$15.11	-	-	-	16.99	-	-	-	4.25	-	-	-
Disposal of muck	9.46	-	-	-	10.40	-	-	-	3.32	-	-	-
Plumbing caisson	12.39	-	.95	-	-	-	-	-	-	-	-	-
Operative labor to sinking	-	-	9.62	$48.34	-	-	12.46	$61.73	-	-	3.37	$24.06
Caisson shoe steel	.47	$4.90	-	-	-	-	-	-	-	-	-	-
Permanent material, misc	.22	1.78	-	-	-	-	-	-	-	-	-	-
Reinforcing	1.95	8.38	-	-	2.18	$5.14	-	-	.63	$0.86	-	-
Panning water	-	-	-	-	1.59	.63	-	-	.45	.07		
Concrete forms, handling	11.83	4.12	6.93	-	10.73	2.09	5.24	-	3.68	-	2.63	-
Concrete mixing and placing	6.68	71.52	-	-	6.98	36.68	-	-	1.94	12.93	-	-
Operative labor to concreting	-	-	4.69	123.47	-	-	7.05	78.31	-	-	1.88	25.07
Pumping	-	-	.96	.96	-	-	5.35	5.35	-	-	-	-
Ventilation	-	-	-	-	-	-	-	-	-	-	1.11	1.11
Power	-	-	6.83	6.83	-	-	10.83	10.83	-	-	2.95	2.95
Construction material, misc	-	-	7.82	7.82	-	-	7.72	7.72	-	-	2.28	2.28
Indirect labor, misc.	-	-	10.26	10.26	-	-	5.72	5.72	-	-	3.01	3.01
Supervision (local office)	-	-	14.46	14.46	-	-	13.59	13.59	-	-	3.69	3.69
Totals	58.11	90.70	63.33	212.14	57.06	44.54	81.65	183.25	19.27	13.86	29.04	62.17

Note: The hoisting engineers time is allocated to the various direct labor items.

TABLE 2.- Labor expended, man-hours

	Caisson & seal		Rock section		Salt section	
	Total	Per foot	Total	Per foot	Total	Per foot
Drilling and blasting	-	-	1,803	11.70	3,339	7.41
Mucking	3,316	28.84	3,460	31.08	3,480	7.72
Disposal	1,857	16.15	1,575	14.15	1,983	4.40
Plumbing caisson	2,712	23.58	-	-	-	-
Concreting	5,733	50.18	3,565	32.02	5,234	12.26
Hoisting	1,264	11.00	1,058	9.50	1,359	3.02
Operative and indirect labor	5,958	51.81	6,342	56 97	7,706	17.10
Totals	20,840	181.56	17,303	155.42	23,101	51.91

	Caisson section	Rock section	Salt section
Vertical feet of shaft per man-shift:	Per 10-hour shift, 0.055;	per 8-hour shift, 0.051;	per 10-hour shift, 0.193.
Average pay per shift:	$4.80	$4.56	$5.46

	Caisson section	Rock section	Salt section
Time worked in shaft........days	79	55	86
Progress:			
Total........feet	115	111.33	450.66
Sinking and lining, per day..do.	1.455	2.02	5.24

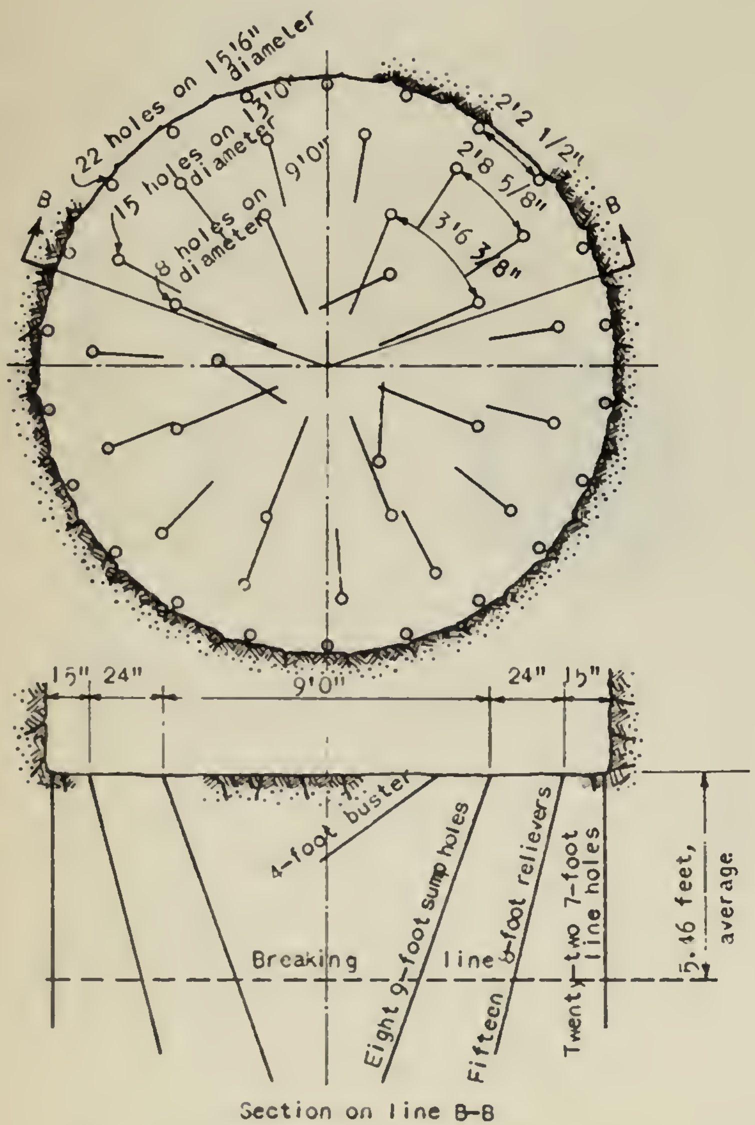

Figure 4.- Drilling diagram in the salt

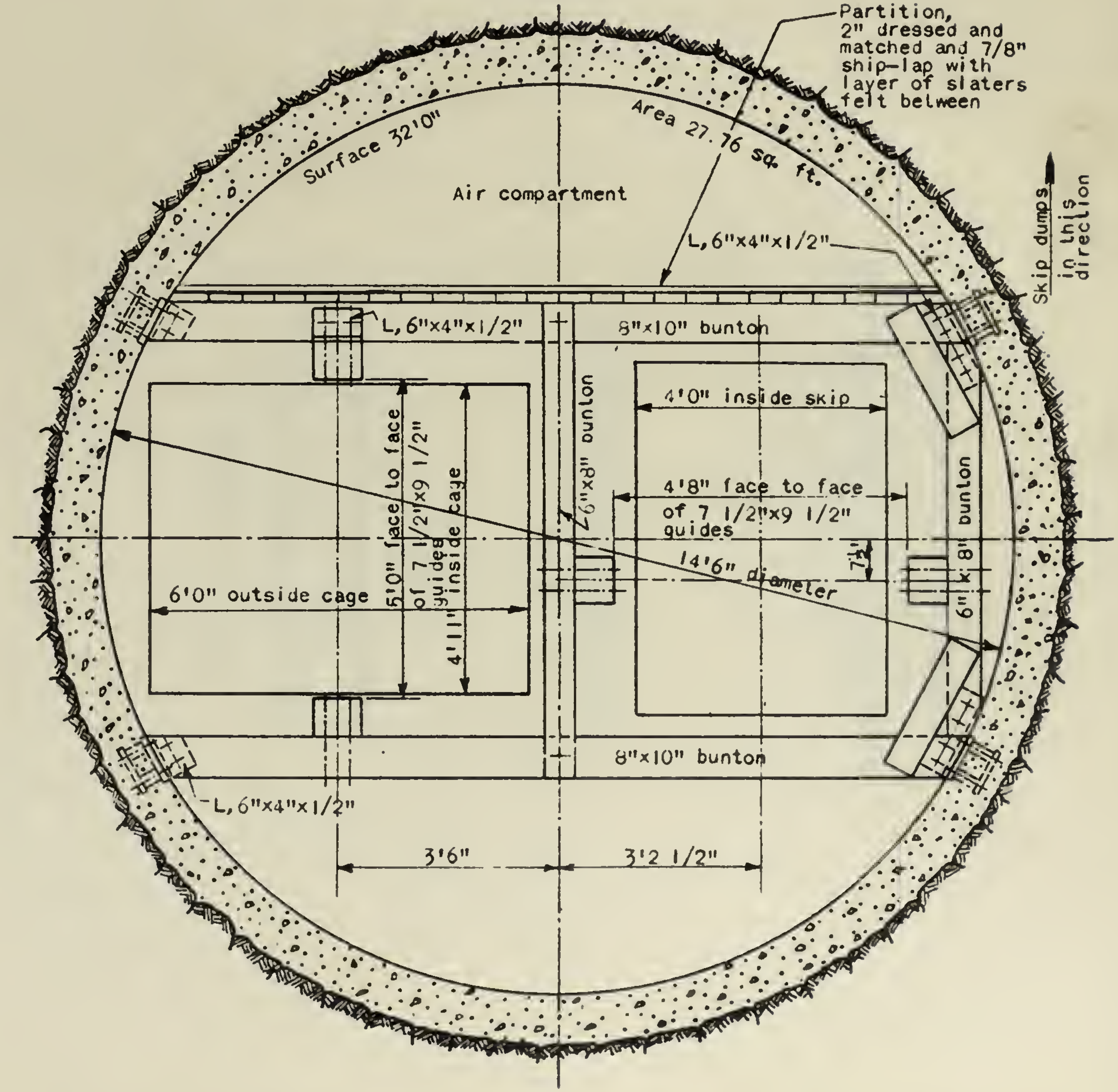

Figure 5.- Typical section of shaft in salt, showing location of guides and skip

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July, 1932

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

PETROLEUM REFINERIES IN THE UNITED STATES JANUARY 1, 1932

BY

G. R. HOPKINS AND E. W. COCHRANE

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

PETROLEUM REFINERIES IN THE UNITED STATES, JANUARY 1, 1932[1]

By G. R. Hopkins[2] and E. W. Cochrane[3]

INTRODUCTORY SUMMARY

According to reports received by the United States Bureau of Mines, as of January 1, 1932, there were 473 completed petroleum refineries in the United States, an increase of 38 over the total reported at the beginning of 1931. This represents the largest annual increase in number of refineries in a number of years. Of the total, 365, or 77 per cent, were operating on January 1, 1932, and 108, or 23 per cent, were idle. In addition, 6 refineries under construction were reported.

The increase in number of refineries in 1931 was due chiefly to the construction of new refineries in the East Texas field and in many small outlying fields in the Mid-Continent. Eighteen refineries were built in the East Texas field in 1931; all were skimming plants and only two were equipped with cracking facilities. The total capacity of the plants in East Texas on January 1, 1932, amounted to 72,500 barrels, but the actual crude throughput on that date amounted to only about 21 per cent of that figure. The majority of the refineries in the outlying fields were constructed by producers who were unable to obtain an outlet for their crude. These plants were practically all of small size and their combined capacity was of negligible importance.

The total daily capacity of all the refineries on January 1, 1932, amounted to 4,020,428 barrels, an increase of 32,743 barrels, or 0.8 per cent, over the previous year. This marked the first time that the total has exceeded the 4,000,000-barrel mark. Although the number of refineries has fluctuated considerably in the last decade, the total daily capacity has shown a steady increase. This gain is considerably below the relative increase in gasoline consumption, but because of the rapid rise in the percentage yield of gasoline, the amount of idle equipment used in straight distillation has grown steadily.

1/The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6641."

2/Economic analyst, U.S. Bureau of Mines.

3/Statistical clerk, U.S. Bureau of Mines.

Of the total capacity on January 1, 3,622,092 barrels, or 90.1 per cent, represents the capacity of the operating plants; 389,616 barrels, or 9.7 per cent, the capacity of the inoperative plants; and 8,720, or 0.2 per cent, the capacity of the six plants under construction. In comparison with the 1931 survey, these data represent decreases of 2 and 81 percent, respectively, in the operative capacity and in that under construction, but an increase of 65 per cent in the inoperative capacity. These percentage changes are noteworthy as indicating the first decline in operative capacity since the first survey was made, the largest inoperative capacity yet recorded and, with one exception, the smallest capacity under construction.

In 1931 the average total capacity of the operating plants amounted to 3,744,000 barrels, and the daily average crude throughput was 2,450,000 barrels. This indicates that the refineries operated at an average of 65 per cent of their capacity, compared with 69 per cent in 1930 and 78 per cent in 1929.

Texas continued to lead in number of refineries, and California in total capacity. The number of completed plants in Texas rose from 97 on January 1, 1931, to 123 on January 1, 1932, the largest increase for any State. Although the same number of plants (55) were operated in California on January 1, 1931, and January 1, 1932, the total operating capacity declined about 50,000 barrels, and the inoperative capacity more than doubled. The majority of the other States showed a decline in capacity of refineries, reflecting the dismantling of obsolete equipment and the falling off in new construction. The list of States with refineries on January 1, 1932, was the same as for the previous year, except for the addition of Alabama.

Skimming plants, or plants which produce gasoline and fuel oil or gasoline, kerosene, and fuel oil, continued to rank first in point of number. The number of skimming plants on January 1, 1932, was 299, an increase of 40 in a year. Second to skimming plants in number were complete plants, or plants which produce all the major products, including wax and asphalt when present in the crude oil processed. There were 90 complete plants in 1932, compared with 89 a year ago. The total capacity of the complete plants greatly exceeded the capacity of the skimming plants. As a further illustration, the total capacity of the 85 complete plants in operation on January 1, 1932, was greater than that of the remaining 280 operating plants. Although there were 18 more skimming plants in operation on January 1, 1932, than on January 1, 1931, the total operating capacity declined nearly 75,000 barrels. This is a reflection of the fact that the majority of the new plants were of small capacity. Actual reports of the 365 plants which were in operation on January 1, 1932, show that 347 were producing gasoline, 256 kerosene, 258 gas oil, 315 residual fuel oil, 105 lubricants, 60 wax, 101 coke, 46 asphalt, and 66 at least one miscellaneous product. These data vary somewhat from the totals obtained through a recapitulation of "type of process," as some plants often temporarily discontinue making a complete line of products.

Continued expansion in cracking facilities was recorded in 1931. Although complete information as to cracking equipment as of January 1, 1932, is not yet available, indications point to a net decrease in the number of refineries which have such equipment, but to an increase of 5 per cent in total charging capacity during 1931.

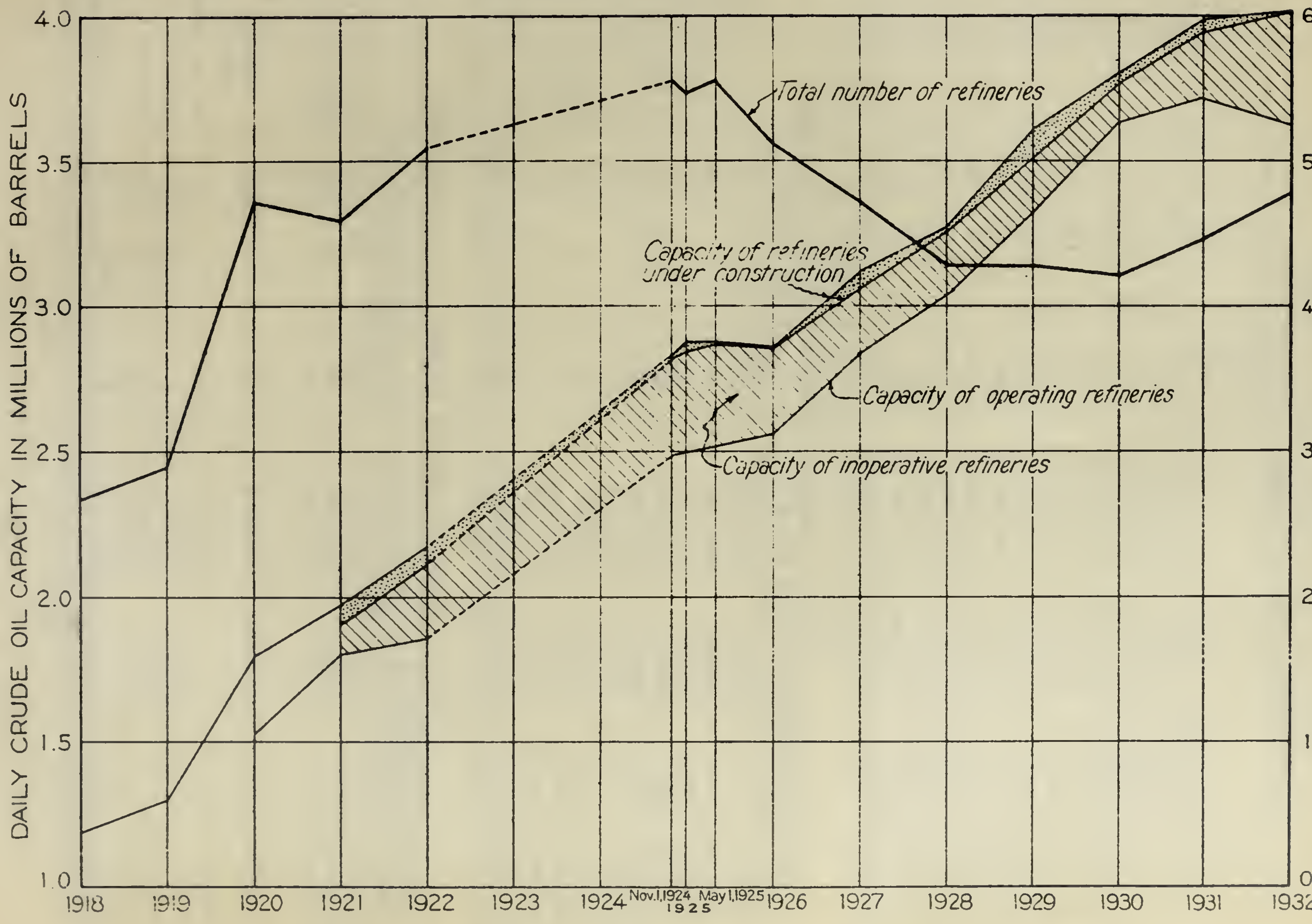
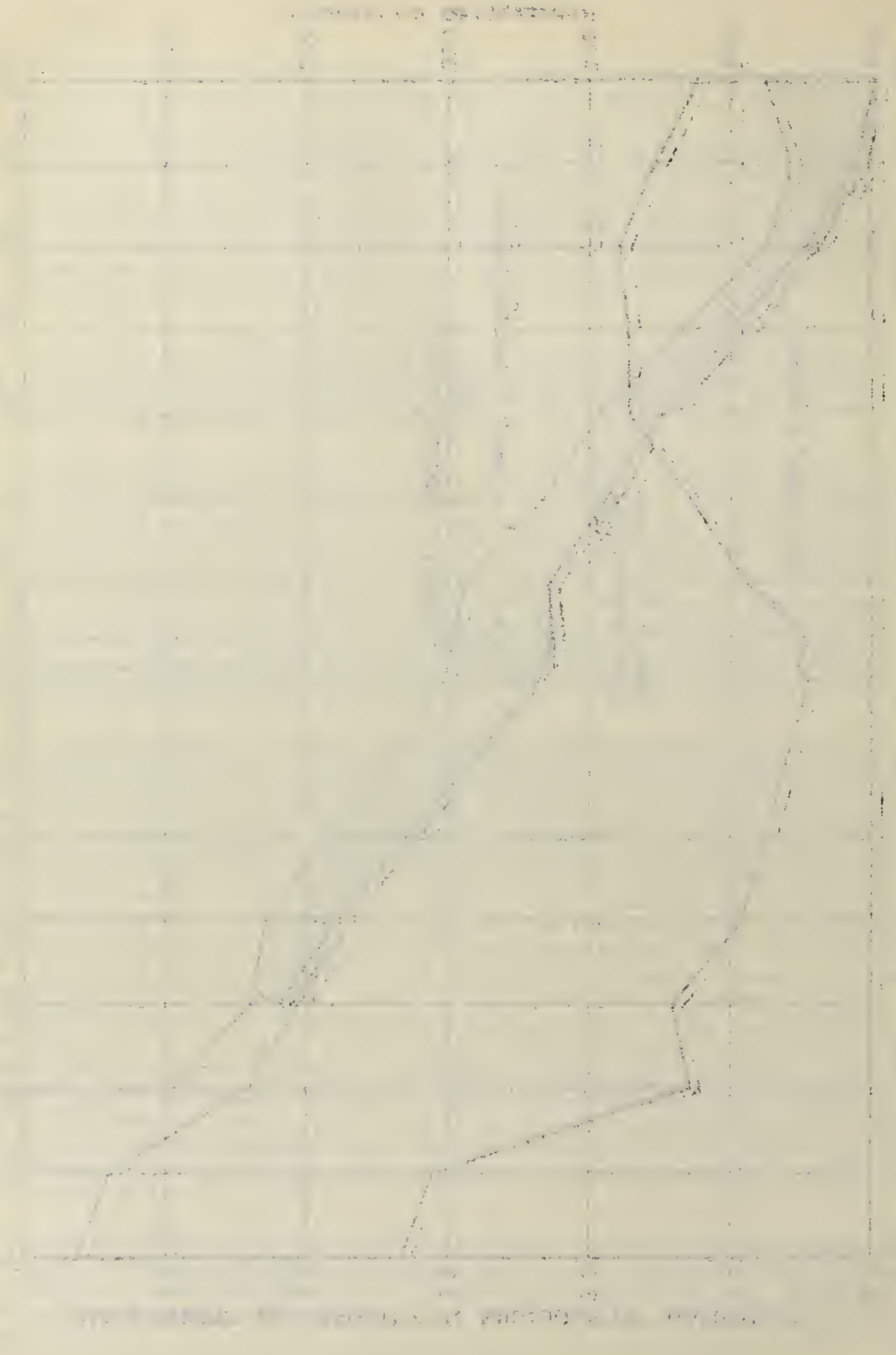


Figure 1.—Number and capacity of petroleum refineries in the United States, Jan. 1, 1918–1932



RECAPITULATION BY YEARS

	Number				Capacity (barrels per day)			
	Op.	S.d.	Bldg.	Total	Operating	Shut down	Building	Total
Jan. 1, 1914 1/..	- -	- -	- -	176	- -	- -	- -	- -
Jan. 1, 1918	- -	- -	- -	267	- -	- -	- -	1,186,155
Jan. 1, 1919	- -	- -	- -	289	- -	- -	- -	1,295,115
Jan. 1, 1920	2/373	(2/)	99	472	2/1,530,565	(2/)	263,500	1,794,065
Jan. 1, 1921	350	65	44	459	1,794,395	94,405	76,600	1,965,400
Jan. 1, 1922	325	154	30	509	1,854,590	254,610	59,950	2,169,150
Nov. 1, 1924	357	190	8	555	2,480,922	333,410	18,200	2,832,532
Jan. 1, 1925	357	184	6	547	2,489,927	337,910	37,000	2,864,837
May 1, 1925	365	185	4	554	2,511,817	342,025	11,000	2,864,842
Jan. 1, 1926	352	158	2	512	2,562,357	290,610	5,500	2,858,467
Jan. 1, 1927	327	138	7	472	2,834,282	226,725	61,000	3,122,007
Jan. 1, 1928	326	97	5	428	3,036,125	214,255	22,000	3,272,380
Jan. 1, 1929	341	72	14	427	3,325,890	183,650	99,000	3,608,540
Jan. 1, 1930	358	54	8	420	3,634,825	130,760	37,200	3,802,785
Jan. 1, 1931	346	89	10	445	3,706,610	236,075	45,000	3,987,685
Jan. 1, 1932	365	108	6	479	3,622,092	389,616	8,720	4,020,428

1/From the Bureau of the Census. 2/Includes inoperative plants.

RECAPITULATION BY DISTRICTS (January 1, 1932)

	Number				Capacity (barrels per day)			
	Op.	S.d.	Bldg.	Total	Operating	Shut down	Building	Total
East coast	24	1	- -	25	619,500	4,000	- -	623,500
Appalachian	50	7	- -	57	151,180	10,750	- -	161,930
Ind.,Ill.,Ky.etc.	39	6	1	46	408,067	12,000	100	420,167
Okla.,Kans., Mo.	55	17	1	73	444,800	57,250	120	502,170
Texas Inland	70	36	1	107	262,165	113,500	1,400	377,065
Texas Gulf	14	3	- -	17	542,000	16,000	- -	558,000
Ark. and La.Inland	13	4	- -	17	80,800	24,100	- -	104,900
La. Gulf	5	1	1	7	146,000	20,000	6,000	172,000
Rocky Mountain ..	40	14	2	56	145,570	13,266	1,100	159,936
California	55	19	- -	74	822,010	118,750	- -	940,760
TOTAL	365	108	6	479	3,622,092	389,616	8,720	4,020,428

RECAPITULATION BY TYPE OF PROCESS (January 1, 1932)

	Number				Capacity (barrels per day)			
	Op.	S.d.	Bldg.	Total	Operating	Shut down	Building	Total
Skimming	208	86	5	299	1,024,812	327,516	8,620	1,360,948
Skimming and lube	23	3	1	27	299,050	11,400	100	310,550
Complete	85	5	- -	90	1,956,230	7,900	- -	1,964,130
Skimming and asphalt	13	2	- -	15	154,500	21,500	- -	176,000
Skimming, lube and asphalt	4	-	- -	4	38,500	- -	- -	38,500
Lube	3	5	- -	8	3,700	3,800	- -	7,500
Asphalt	8	3	- -	11	28,500	9,000	- -	37,500
Topping	20	4	- -	24	116,500	8,500	- -	125,000
Miscellaneous ...	1	-	- -	1	300	- -	- -	300
Total	365	108	6	479	3,622,092	389,616	8,720	4,020,428

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RECAPITULATION BY STATES (January 1, 1932)

State	Number				Capacity (barrels per day)			
	Op.	S.d.	Bldg	Total	Operating	Shut down	Building	Total
Alabama	-	-	1	1	--	--	6,000	6,000
Arizona	-	1	-	1	--	1,000	--	1,000
Arkansas	8	1	-	9	41,000	5,500	--	46,500
California	55	19	-	74	822,010	118,750	--	940,760
Colorado.......	5	-	-	5	5,630	--	--	5,630
Georgia	1	1	-	2	5,000	4,000	--	9,000
Illinois.......	10	1	-	11	128,200	1,000	--	129,200
Indiana........	6	-	-	6	171,050	--	--	171,050
Iowa...........	-	1	-	1	--	2,000	--	2,000
Kansas	14	2	1	17	140,000	14,000	120	154,120
Kentucky.......	8	2	1	11	26,100	6,500	100	32,700
Louisiana	10	4	-	14	185,800	38,600	--	224,400
Maryland	3	-	-	3	50,000	--	--	50,000
Massachusetts	2	-	-	2	48,000	--	--	48,000
Michigan	6	2	-	8	14,600	2,500	--	17,100
Missouri	2	-	-	2	19,500	--	--	19,500
Montana	12	8	-	20	16,500	10,580	--	27,080
New Jersey ...	7	-	-	7	310,000	--	--	310,000
New Mexico ...	7	1	-	8	5,300	100	--	5,400
New York	4	-	-	4	40,500	--	--	40,500
Ohio	14	1	-	15	101,122	2,000	--	103,122
Oklahoma	39	14	-	53	285,300	41,250	--	326,550
Pennsylvania .	41	7	-	48	247,500	10,750	--	258,250
Rhode Island ..	2	-	-	2	11,500	--	--	11,500
South Carolina	1	-	-	1	6,000	--	--	6,000
Tennessee	1	-	-	1	75	--	--	75
Texas	84	39	1	124	804,165	129,500	1,400	935,065
Utah	1	2	1	4	6,000	800	1,000	7,800
Virginia	1	-	-	1	1,500	--	--	1,500
West Virginia	6	-	-	6	17,600	--	--	17,600
Wyoming	15	2	1	18	112,140	786	100	113,026
Total..	365	108	6	479	3,622,092	389,616	8,720	4,020,428

In order to show the connection between this census and the refinery districts as recognized in the refinery statistics of the United States Bureau of Mines, the following symbols have been attached to the refineries to indicate the divisions to which they have been assigned:

a/ East coast
b/ Appalachian
c/ Indiana, Illinois, Kentucky, etc.
d/ Oklahoma, Kansas, Missouri
e/ Texas Inland
f/ Arkansas and Louisiana Inland
g/ Rocky Mountain
h/ California
i/ Texas Gulf coast
j/ Louisiana Gulf coast

EXPLANATION OF SYMBOLS

Status:
1. Op. denotes operating on January 1, 1932.
2. S.d. denotes shut down on January 1, 1932.
3. Bldg. denotes building on January 1, 1932.
4. Rebldg. denotes rebuilding on January 1, 1932 - classed as shut down in recapitulation totals.
5. (*) denotes possession of cracking equipment.

Location: The location given is the plant location, which does not always correspond with the office address of the company. For mailing addresses the standard catalogues of the petroleum industry are better references.

Daily capacity: The capacity given represents the average daily crude throughput of the plant in complete operation, expressed in barrels of 42 U.S. gallons. There is no hard and fast rule governing the size of plants, for where refineries are partly or completely shut down the rated capacity often varies with personal opinion. Furthermore, crude throughput fluctuates with the nature of the products derived. For example, the capacity of a plant engaged only in skimming is much greater than if lubricating oils are being produced.

Railroads: The railroads noted are those over which tank cars have access to the refinery.

Type of plant: Eight common types of plants are given in this directory and are listed below, together with the products commonly obtained. At one time it was the custom not to consider a plant "complete" unless it made either coke or asphalt. However, because of the fact that some refiners do not run to coke, or use crudes containing little or no asphalt, it was thought advisable to change the lines of demarcation. In general, a complete plant east of California is one which produces all the common products, including wax; in California a complete plant is one which produces all the common products through lubricating oils.

Skimming plant (Skim.)	Skimming and lube (S. & L.)	Complete plant (Comp.)	Skimming and asphalt (S. & A.)
Gasoline	Gasoline	Gasoline	Gasoline
Kerosene	Kerosene	Kerosene	Kerosene
Gas oil and fuel oil	Gas oil and fuel oil	Gas oil and fuel oil	Gas oil and fuel oil
	Lubricating oils	Lubricating oils	Asphalt
		Wax, if present in the crude	

Skimming, lube, and asphalt, (S.L.&A.)	Lube plant (Lube)	Asphalt plant (Asph)	Topping plant (Top)
Gasoline	Gas oil and fuel oil	Distillates	Tops
Kerosene	Lubricating oils	Gas oil and fuel oil	Distillates
Gas oil and fuel oil		Asphalt	Gas oil and fuel oil
Lubricating oils			
Asphalt			

DETAIL BY STATES

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	ALABAMA j/				
Bldg.	Coastal Pet. Corp.	AT&N, GM&N, M&O, L&N, So.	Mobile	6,000	*Skim.
				6,000	
	ARIZONA g/				
S.d.	Rio Grande Oil Co.	Santa Fe, SP	Phoenix	1,000	Skim.
				1,000	
	ARKANSAS f/				
Op.	Berry Asphalt Co.	Reader	Waterloo	2,000	Asph.
Op.	Henry H. Cross Co.	MoP	Smackover	6,000	Skim.
S.d.	Houston Oil Co. of Texas	MoP, St.L&SW	Camden	5,500	*Skim.
Op.	Kettle Creek Refg. Co.	E&W, RI	El Dorado	5,000	*Skim.
Op.	Lion Oil Refg. Co.	E&W, MoP, RI	do.	11,000	*S&A.
Op.	Macmillan Pet. Corp.	MoP, RI	Norphlet	2,500	SL&A.
Op.	Ouachita Valley Refg. Co.	MoP, RI	El Dorado	2,000	*Skim.
Op.	Root Refg. Co.	MoP	do.	10,000	*Skim.
Op.	Simms Oil Co.	MoP	Smackover	2,500	*Skim.
				46,500	
	CALIFORNIA 4/ h/				
Op.	Andrews, Wm. P. Oil Co.	UP	Long Beach	2,000	Top
Op.	Andrews, Wm. P. Oil Co.	SP	Newhall	2,000	Top
Op.	Associated Oil Co.	SP	Avon	58,500	*Comp.
Op.	do.	Sunset	Taft	1,500	Top
Op.	do.	PE	Watson	18,000	Comp.
Op.	Bush, R.R. Refg. Co.	UP	Long Beach	3,000	Top
S.d.	Calif. Northern Pet. Corp.	SP	Coalinga	200	Lube
Op.	Capitol Crude Oil Co.	SP	Santa Paula	160	Skim.
Op.	Caminol Co. (Ltd.)	Santa Fe	Santa Fe Springs	3,500	Skim.
Op.	Champion Gasoline Co.	UP	Long Beach	4,000	Skim.
S.d.	Chansler Canfield Midway Oil Co.	Santa Fe	Olinda	2,000	Top

4/ Data compiled by E. T.Knudsen of the San Francisco office of the U. S. Bureau of Mines.

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	CALIFORNIA (Cont'd) h/				
Op.	Cherry Oil Co.	UP	Long Beach	1,000	Skim.
Op.	Consolidated Pacific Oil Co.	Santa Fe	Santa Fe Springs	1,000	Skim.
S.d.	Devil's Den Products Co.	--	Devil's Den	50	Lube
S.d.	East West Refg. Co.	SP	Los Angeles	2,000	Skim.
Op.	Edington Witz Refg. Co.	UP	Long Beach	4,000	Skim.
Op.	Estado Pet. Corp. (Ltd.)	PE	do.	5,000	Top
Op.	Exeter Oil Co.(Ltd)	UP	Hynes	6,500	Top
Op.	General Pet. Corp. of Calif.	SP	Lebec	12,000	Skim.
Op.	do.	Santa Fe	Los Angeles	50,000	Comp.
Op.	do.	Santa Fe	Torrance	35,000	Skim.
Op.	Gilmore Oil Co.(Ltd.)	SP	Los Angeles	2,500	S&A
Op.	do.	SP	do.	2,000	Skim.
Op.	do.	SMV	Roadamite	700	Skim.
Op.	Hancock Refg. Co.	UP	Long Beach	12,000	Top
S.d.	Hercules Gasoline Co.	Santa Fe, SP	Los Angeles	5,500	*Skim.
S.d.	Holly Oil Co.	SP	Huntington Beach	3,000	Skim.
Op.	Kettleman Hills Gasoline Co.	Santa Fe	Hanford	2,500	Top
Op.	Lakeview Oil & Refg. Co.	Sunset	Maricopa	2,000	Skim.
Op.	Macmillan Pet. Corp.	PE	Long Beach	10,000	Top
Op.	M.M. McCallen Refg. & Prod. Co.	--	Huntington Beach	500	Asph.
Op.	Monarch Refiners, (Ltd.)	PE	Venice	3,000	Top
Op.	Norwalk Co.	Sunset	Taft	2,500	Top
Op.	Olympic Refg. Co.	UP	Long Beach	5,500	Top
Op.	Orange County Refg.Co.	SP	Newport Beach	300	Asph
Op.	Palisades Oil & Refg.Co.	SP	Vinvale	3,500	Top
Op.	Paraffine Companies (Inc.)	SP	Emeryville	1,200	Asph.
Op.	Petrol Corp.	Santa Fe, SP	Los Angeles	5,000	Skim.
Op.	Petroleum Specialities, Co.	do.	Los Angeles	2,000	Skim.
S.d.	Richfield Oil Co. of Calif.	Santa Fe	Bakersfield	2,000	Skim.
S.d.	do.	UP	Hynes	55,000	*Skim.
S.d.	do.	Santa Fe, SP	Los Angeles	4,000	Skim.
Op.	do.	PE	Watson	50,000	*Comp.

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Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	CALIFORNIA (Cont'd.)h/				
S.d.	Rio Grande Oil Co.	SP	Vinvale	10,000	*Skim.
Op.	St.Helens Pet. Co. (Ltd.)	UP	Whittier	5,000	Skim.
S.d.	Seaboard Pet.Corp.	Santa Fe,SP	Los Angeles	1,500	Skim.
S.d.	Seaside Oil Co.	SP	Summerland	2,000	Asph.
Op.	do.	SP	Ventura	5,000	S&A
Op.	Shell Oil Co.	SP	Coalinga	4,000	Skim.
Op.	do.	SP	Martinez	40,000	*Comp.
Op.	do.	PE	Watson	60,000	*Comp.
Op.	Signal Oil & Gas Co.	UP	Hynes	5,000	Skim.
S.d.	Southwest Refg. Co.	UP	Long Beach	1,000	Top
Op.	Standard Oil Co. of Calif.	Santa Fe	El Segundo	100,000	*Comp.
Op.	do.	Santa Fe,SP	Richmond	100,000	*Comp.
Op.	do.	do.	Seguro(Bakersfield)	25,000	S&A
S.d.	Sunset Pacific Oil Co.	do.	Los Angeles	10,000	Skim.
Op.	The Texas Co.	SP	Coalinga	500	Top
Op.	do.	SP	Fillmore	4,000	*Comp.
Op.	do.	SP	Watson	30,000	*Top
Op.	Torrance Oil & Refg. Co.	Santa Fe	Torrance	5,000	Skim.
Op.	Triangle Oil & Refg. Co.	PE	Venice	250	Skim.
S.d.	Union Oil Co. of Calif.	PC	Avila	10,000	Skim.
S.d.	do.	PE	Brea	6,000	Skim.
Op.	do.	SP	Maltha(Bakersfield)	5,000	Skim.
Op.	do.	SP	Oleum	30,000	Comp.
Op.	do.	SP	Santa Paula	900	Skim.
Op.	do.	PE	Wilmington	55,000	*Comp.
S.d.	Union Pacific Oil Co.	UP	Long Beach	2,000	Skim.
Op.	Vernon Oil Refg. Co.	Santa Fe,SP	Los Angeles	3,000	Skim.
S.d.	Vulcan Refg.Co.	do.	do.	1,500	*S&A
Op.	Western Oil & Refg.Co.	PE	Wilmington	12,000	*Skim.
S.d.	Wilshire Oil Co.(Inc.)	Sunset	Fellows	1,000	Skim.
Op.	do.	Santa Fe,SP	Los Angeles	20,000	Skim.
				940,750	

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	COLORADO g/				
Op.	Berthoud Refg. Co.	none	Berthoud	30	Skim.
Op.	Continental Oil Co.	CB&Q, UP	Denver	1,500	*Skim.
Op.	do.	D&RGW, Santa Fe	Florence	3,000	*Skim.
Op.	Raven Oil & Refg.Co.	none	Rangely	100	Skim.
Op.	The Texas Co.	D&SL	Craig	1,000	*Skim.
				5,630	
	GEORGIA a/				
Op.	The Atlantic Refg.Co.	ACL, So.	Brunswick	5,000	*Comp.
S.d.	Mexican Pet.Corp.of Ga.	S&A	Savannah	4,000	Asph.
				9,000	
	ILLINOIS c/				
S.d.	Henry H. Cross Co.	E St.LC&W	Dupo	1,000	Skim.
Op.	do.	EJ&E	Joliet	2,500	Skim.
Op.	The Globe Oil & Refg.Co.	C&A, SantaFe	Lemont	6,500	*Skim.
Op.	Indian Refg.Co.	B&O, CCC&St.L	Lawrenceville	16,000	*Comp.
Op.	Lincoln Oil Refg.Co.	CCC&St.L, IC	Robinson	10,000	*Comp.
Op.	Lubrite Refg.Corp.	A&S	E. St.Louis	3,500	*Skim.
Op.	Red River Refg. Co.(Inc)	BOCT	Burnham	1,200	Lube
Op.	Shell Pet.Corp.	C&A, CCC & St.L, IT	Wood River	38,000	*S&L
Op.	Standard Oil Co.(Ind.)	C&A, CCC&St. L, IT	do.	25,000	*Comp.
Op.	The Texas Co.	C&A, Santa Fe	Lockport	20,000	*Comp.
Op.	White Star Refg.Co.	IT	Wood River	5,500	*Skim.
				129,200	
	INDIANA c/				
Op.	Bartles-Maguire Oil Co.	IHB	E.Chicago	5,000	*Skim.
Op.	Empire Oil & Refg.Co.	BOCT, EJ&E, IHB	do.	25,000	*Skim.
Op.	Shell Pet. Corp.	IHB	do.	26,000	*Skim.
Op.	Sinclair Refg.Co.	BOCT, EJ&E, IHB, PRR	do.	40,000	*Comp.
Op.	Standard Oil Co.(Ind.)	BOCT, CT, EJ&E, IHB, NYC, PRR	Whiting	75,000	*Comp.
Op.	Troy Refg. Corp.	none	Troy	50	Skim.
				171,050	

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	IOWA d/				
S.d.	Mona Motor Oil Co.	IC	E. Omaha	2,000	Skim.
				2,000	
	KANSAS d/				
Op.	Altitude Pet.Corp.	Santa Fe	Chanute	3,000	*Skim.
Op.	Barnsdall Refineries (Inc.)	MV, Santa Fe	Wichita	4,000	*Skim.
Op.	Derby Oil Co.	Frisco, KCM&O, MoP, RI, Santa Fe	Wichita	8,000	*Skim.
Op.	El Dorado Refg.Co.	Santa Fe	El Dorado	4,500	*Skim.
Op.	Golden Rule Refg.Co.	Wichita Term.	Wichita	1,000	*Skim.
S.d.	Hutchinson Oil Refg. Co.	RI, Santa Fe, SP	Hutchinson	3,000	*Skim.
Op.	Independent Oil & Gas Co.	MoP, UP	Kansas City	8,000	*S&L
Op.	Kanotex Refg. Co.	Frisco, MoP, MV, Santa Fe	Arkansas City	12,000	*Skim.
Rebldg.	Kreuger Oil Co.	UP	Natoma	120	Skim.
Op.	National Refg.Co.	MKT	Coffeyville	5,500	*Comp.
Op.	Shell Pet. Corp.	Frisco, MoP, MV, Santa Fe	Arkansas City	20,000	*Skim.
S.d.	Sinclair Refg.Co.	Santa Fe	Argentine	11,000	*Skim.
Op.	do.	MKT, MoP, Santa Fe	Coffeyville	12,000	*Comp.
Op.	Skelly Oil Co.	MoP, Santa Fe	El Dorado	23,000	*Skim.
Op.	The Standard Oil Co. (Kans.)	Frisco, MoP	Neodesha	20,000	*Skim.
Op.	Vickers Pet. Co. of Del.	MoP	Potwin	4,000	*Skim.
Op.	White Eagle Oil Corp.	Frisco, Santa Fe	Augusta	15,000	*Skim.
				154,120	
	KENTUCKY c/				
Op.	Aetna Oil Service, Inc.	K&IT	Louisville	2,000	*Skim.
Op.	Ashland Refg. Co.	C&O	Catlettsburg	4,000	*S&A
S.d.	Bowling Green Refg. Co.(Inc.)	L&N	Memphis Jct.	1,500	Skim.
Op.	Glasgow Oil & Refg. Co.	L&N	Glasgow	200	Skim.
Bldg.	Greenville Refg. Co.(Inc.)	none	Greenville	100	Skim.

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	KENTUCKY (Cont'd)c/				
Op.	Latonia Refg. Corp.	L&N	Latonia	8,000	*S&A
Op.	Louisville Refg.Co.(Inc.)	K&IT	Louisville	4,000	*Skim.
Op.	Simrall Refg.Corp.	L&N	Horse Cave	2,400	Skim.
S.d.	Standard Oil Co(Ky.)	IC, K&IT	Louisville	5,000	Skim.
Op.	Stoll Oil Refg.Co.(Inc)	L&N	do.	3,500	Comp.
Op.	The Texas Co.	L&N	Pryse	2,000	*Skim.
				32,700	
	LOUISIANA f/ j/				
Op.	Bayou State Refg.Corp.	T&P	f/Hosston	800	Lube
Op.	Chalmette Pet.Corp.	KCSo.	j/Chalmette	6,000	*Skim.
S.d.	Crystal Oil Refg. Corp.	KCSo.	f/Cedar Grove	15,000	*Skim.
S.d.	Gupeco Refg. Co. (Inc.)	MoP	f/Alexandria	600	Lube
S.d.	Louisiana Oil Refg.Corp.	L&A, St.L&SW	f/Bossier City	3,000	Asph.
Op.	Louisiana Oil Refg.Corp.	KCSo.	f/Gas Center	18,000	Skim.
Op.	Mexican Pet. Corp. of La. (Inc.)	Y&MV	j/Destrehan	20,000	SL&A
Op.	Shell Pet. Corp.	Y&MV, L&A	j/Norco	16,000	*S&A
S.d.	Sinclair Refg. Co. of La.(Inc.)	LaSo.	j/Meraux	20,000	S&A
Op.	Spartan Refg. Co.(Inc)	IC, T&P	f/Shreveport	10,000	*Skim.
Op.	Standard Oil Co. of La.	L&A, MoP SP, Y&MV	j/Baton Rouge	100,000	*Comp.
Op.	Stanolind Oil & Gas Co.	KCSo.	f/Superior	4,500	*Skim.
Op.	The Texas Co.	T&P	f/Shreveport	6,500	Top
Op.	U.S. Refg. Co.	----	j/Southport	4,000	Skim.
				224,400	
	MARYLAND a/				
Op.	Continental Oil Co.	B&O, WMd.	Baltimore	10,000	*Skim.
Op.	Mexican Pet. Corp.(Me.)	B&O, PRR, WMd.	do.	8,000	S&A
Op.	Standard Oil Co.of N.J.	B&O, Canton, PRR, WMd.	do.	32,000	*Comp.
				50,000	
	MASSACHUSETTS a/				
Op.	Cities Service Refg.Co.	Fore River, NYNH&H	E. Braintree	20,000	*Comp.
Op.	Colonial Beacon Oil.Co.	B&A, B&M	Everett	28,000	*S&A
				48,000	
	MICHIGAN c/				
S.d.	Henry H. Cross Co.	PM	Muskegon	1,000	Skim.
Op.	Naph-Sol Refg. Co.	Grand Trunk PM, PRR	do.	1,500	Skim.
Op.	Old Dutch Refg. Co.	Grand Trunk	do.	3,000	Skim.
Op.	Peerless Oil Co.	PM	Big Rapids	300	Skim.
Op.	do.	PM	Saginaw	300	Skim.
Op.	Roosevelt Oil Co.	AA, PM	Mt.Pleasant	2,500	S&L
S.d.	Standard Oil Co.(Ind.)	MC, PM	Zilwaukee	1,500	Skim.
Op.	White Star Refg.Co.	DT&I	Trenton	7,000	*Skim.
				17,100	

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	MISSOURI d/				
Op.	Joplin Refg.Co.	Frisco, MoP	Joplin	1,500	*Skim.
Op.	Standard Oil Co.(Ind.)	KCSo. Santa Fe	Sugar Creek	18,000	*Comp.
				19,500	
	MONTANA g/				
Op.	Aranow Refinery	----	Kalispell	200	Skim.
S.d.	Arro Oil & Refg. Co.	CMSt.P&P,GN	W.Lewistown	2,000	*Skim.
Op.	Bighorn Oil & Refg.Co.	CB&Q,GN,NP	Billings	2,500	S&L
Op.	Big West Oil Co.	GN	Kevin	1,000	Skim.
S.d.	The Conrad Refg.Co.	GN	Conrad	1,500	Skim.
S.d.	Consumers Refg.Co.	GN	Collins	750	Skim.
Op.	Continental Oil Co.	CMSt.P.&P	S.Lewistown	1,500	Skim.
Op.	Hart Refineries	GN	Hedgesville	100	Skim.
Op.	do.	CM St.P&P,NP	Missoula	400	*Skim.
Op.	Home Oil & Refg.Co.	CMSt.P&P,GN	Great Falls	1,000	Skim.
Op.	International Refg.Co.	GN	Sunburst	4,500	*Skim.
S.d.	Laurel Oil & Refg. Co.	CB&Q, GN,NP	Laurel	1,500	*Skim.
Op.	Northwest Stellarene Co.	GN	Shelby	1,500	Skim.
Op.	Russell Oil Co.	CB&Q,GN,NP	Billings	1,500	Skim.
S.d.	do.	BA&P,CMSt.P&P, GN,NP,UP	Butte	1,000	Skim.
S.d.	Snow Cap Oil.Co.	GN	Sunburst	330	Skim.
S.d.	Sunburst Oil & Refg.Co.	CMSt.P&P, GN	Great Falls	3,000	Skim.
Op.	Toole County Refg.Co.	GN	Oilmont	300	Skim.
Op.	Yale Oil Corp. of S.D.	CB&Q, GN, NP	Billings	2,000	Skim.
S.d.	do.	CM&St.P&P,NP	Miles City	500	Skim.
				27,080	
	NEW JERSEY a/				
Op.	The Barber Asphalt Co.	CRRNJ, LV,PRR	Maurer	4,000	*S&A
Op.	Crew Levick Co.	PRR	Petty Island	8,000	*Skim.
Op.	Gulf Refg.Co.	CRRNJ	Bayonne	30,000	*Skim.
Op.	Standard Oil Co.of N.J.	CRRNJ, LV,PRR	Bayonne,etc	180,000	*Comp.
Op.	Tide Water Oil Co.	CRRNJ, EJ&T,LV	Bayonne	50,000	*Comp.
Op.	Vacuum Oil Co.(Inc.)	PRR	Paulsboro	20,000	*Comp.
Op.	Warner Quinlan Co.	CRRNJ	Warners	18,000	S&A
				310,000	
	NEW MEXICO g/				
S.d.	The Aerox Oil Co.	none	Bloomfield	100	Skim.
Op.	Continental Oil Co.	Santa Fe	Albuquerque	1,000	Skim.
Op.	do.	do.	Artesia	1,000	Skim.
Op.	do.	D&RGW	Farmington	1,000	Skim.
Op.	Malco Refineries (Inc.)	Santa Fe	Artesia	1,500	Skim.
Op.	Pecos Diamond Refg.Co.	none	do.	250	Skim.
Op.	Valley Refg.Co.	Santa Fe	Roswell	500	Skim.
Op.	Walker Oil Corp.	none	Hobbs	50	Skim.
				5,400	

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	NEW YORK a/ b/				
Op.	Sinclair Refg. Co.	B&S	b/Wellsville	10,000	*Comp.
Op.	Standard Oil Co. of N.Y.(Inc)	LIRR	a/Brooklyn & Long Island City	19,000	*Comp.
Op.	do.	BCRR	b/Buffalo	5,000	*Comp.
Op.	Vacuum Oil Co.(Inc.)	ERR,PRR	b/Olean	6,500	*Comp.
				40,500	
	OHIO b/ c/				
Op.	Allegheny Arrow Oil Co.	PRR, W&LE	b/Canton	1,500	*Skim.
Op.	Canfield Oil Co.	W&LE	b/Cleveland	1,000	Comp.
S.d.	Craig Oil Co.	W&LE	c/Toledo	2,000	Comp.
Op.	Gulf Refg. Co.(Del.)	B&O, CCC&StL	c/Hooven	12,000	*S&A
Op.	do.	W&LE	c/Toledo	12,000	*Skim.
Op.	National Refg. Co.	NYC&St.L	c/Findlay	2,000	Comp.
Op.	do.	B&O	b/Marietta	580	*Comp.
Op.	Peninsula Oil Co.	NYC	c/Port Clinton	42	Skim.
Op.	The Pure Oil Co.	B&O,NYC,PRR	b/Heath	9,000	*S&L
Op.	do.	Toledo Term.	c/Toledo	6,500	*Skim.
Op.	The Standard Oil Co.(Ohio)	B&O,ERR	b/Cleveland	20,000	*Comp.
Op.	do.	ERR,NYC&St. L, PRR	c/Lima	7,500	*Comp.
Op.	do.	Toledo Term.	c/Toledo	16,000	*Comp.
Op.	Stellar Refg. Co.	PRR	b/Marne	1,000	*Skim.
Op.	Sun Oil Co.	Toledo Term.	c/Toledo	12,000	*Skim.
				103,122	
	OKLAHOMA d/				
Op.	Anderson-Prichard Refg.Co.	Frisco	Cyril	6,000	*Skim.
Op.	Barnsdall Refineries (Inc.)	MV	Barnsdall	5,000	*Comp.
Op.	do.	Frisco,ON	Okmulgee	11,000	*Skim.
Op.	Bell Oil & Gas Co.	MKT, RI	Grandfield	4,500	*Skim.
Op.	Black Gold Refg.Co.	Frisco,RI, Santa Fe	Oklahoma City	1,500	Skim.
S.d.	Capitol Prod.&Refg.Co.	Frisco, Santa Fe	do.	2,000	Skim.
Op.	Century Pet.Co.	RI	do.	2,500	Skim.
S.d.	do.	MV	W. Tulsa	2,500	Skim.
Op.	Champlin Refg. Co.	Frisco,RI, Santa Fe	Enid	16,000	*Comp.
S.d.	Citizens Refg.Co.	RI	Seminole	400	Skim.
Op.	Continental Oil Co.	RI,Santa Fe	Ponca City	30,000	*Comp.
Op.	do.	Frisco	Sapulpa	4,000	*Skim.
Op.	Cushing Refg.&Gaso.Co.	Frisco, Santa Fe	Blackwell	1,800	Skim.
Op.	do.	MKT,Santa Fe	Cushing	4,500	Skim.
Op.	Deep Rock Oil Corp.	MKT,Santa Fe	Cushing	10,000	*Comp.
Op.	Eason Oil Co.	Frisco,RI, Santa Fe	Enid	5,000	*Skim.

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	OKLAHOMA (Cont'd) c/				
S.d.	Empire Oil & Refg. Co.	MKT, Santa Fe	Cushing	5,000	*Skim.
Op.	do.	Frisco, ON	Okmulgee	4,000	*Comp.
Op.	do.	RI, Santa Fe	Ponca City	12,000	*Comp.
Op.	Garber Refinery (Inc.)	RI	Garber	5,000	*Skim.
S.d.	The Gilrey Oil Co.	Santa Fe	Ringling	1,500	Skim.
Op.	The Globe Oil & Refg. Co.	Frisco, Santa Fe	Blackwell	8,000	*Skim.
Op.	Gulf States Corp.	RI	Oklahoma City	3,000	Skim.
S.d.	Illinois Oil Co.	MKT, Santa Fe	Cushing	2,500	Skim.
S.d.	Imperial Refg. Co.	Santa Fe	Ardmore	4,000	*Skim.
Op.	Independent Oil & Gas Co.	Frisco, ON	Okmulgee	5,000	*Comp.
Op.	Indian Territory Ill. Oil Co.	Santa Fe	Oklahoma City	10,000	Top.
Op.	Johnson Oil Refg. Co.	MKT	Cleveland	6,000	*Skim.
Op.	Major Pet. Products Co.	Frisco	Oklahoma City	1,000	Skim.
S.d.	Marathon Oil Co.	do.	Boynton	2,500	*Comp.
Op.	do.	Frisco	Bristow	5,000	*Skim.
Op.	Mid-Continent Pet. Corp.	Frisco, MV	W. Tulsa	40,000	*Comp.
S.d.	Miller Bros.	none	Marland	50	Skim.
Op.	Peppers Gaso. Co.	Frisco	Covington	1,000	Skim.
Op.	Producers & Refiners Corp.	Frisco, MKT, MV, Santa Fe	W. Tulsa	6,000	*Skim.
Op.	Producers Oil Co.	Frisco	Bristow	1,500	Skim.
Op.	The Pure Oil Co.	Frisco, SantaFe	Ardmore	2,500	*Skim.
Op.	do.	Frisco, KO&G, MKT, MV, SantaFe	Muskogee	9,000	*Comp.
Op.	Rock Island Refg. Co.	RI	Duncan	5,000	*Skim.
S.d.	Scott Refg. Co.	RI	Sayre	300	Skim.
Op.	Sinclair Refg. Co.	Santa Fe	Sand Springs	8,000	*Comp.
S.d.	Sterling Refg. Co.	---	Oklahoma City	2,500	Skim.
Op.	Sun Co. of Del.	MKT, Santa Fe	Yale	6,000	Skim.
S.d.	Sunray Oil Co.	KO&G	Allen	7,000	Skim.
Op.	The Texas Co.	Frisco, MV	W. Tulsa	14,000	*Comp.
S.d.	Texas Pacific Coal&OilCo.	Santa Fe	Wynnewood	3,000	*Skim.
Op.	Tidal Refg. Co.	Frisco, SantaFe	Drumright	18,000	*Skim.
Op.	Western Oil Corp.	RI	Duncan	1,500	*Skim.
S.d.	White Oak Corp.	KO&G	Allen	8,000	*S&L
Op.	H. F. Wilcox Oil & Gas Co.	Frisco	Bristow	4,000	*Skim.
Op.	Wirt Franklin Pet. Corp.	Frisco, RI	Ardmore	4,000	Skim.
Op.	Yale Oil Corp.	MKT, Santa Fe	Yale	2,000	Skim.
Op.	York Refg. Co.	Okla. Ry. Co.	Oklahoma City	2,000	Skim.
				326,550	

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	PENNSYLVANIA a/b/				
Op.	The Atlantic Refg. Co.	ERR, NYC	b/Franklin	9,000	*Comp.
Op.	do.	B&O, PRR	a/Philadelphia	50,000	*Comp.
Op.	do.	PRR	b/Pittsburgh	8,000	*Comp.
Op.	Bradford Oil Refg.Co.	B&O,ERR,PRR	b/Bradford	1,500	S&L
Op.	Canfield Oil Co.	ERR, P&LE	b/Coraopolis	1,000	S&L
Op.	Carnegie Refg.Co.	PC&Y, PRR	b/Carnegie	1,000	Comp.
S.d.	Conewango Refg. Co.	NYC	b/Langdale	2,450	*Lube
Op.	do.	NYC	b/Warren	1,700	Lube
Op.	Continental Refg. Co.	PRR	b/Oil City	1,000	Comp.
Op.	Crew Levick Co.	NYC,PRR	b/Titusville	3,000	Comp.
Op.	Crystal Oil Works	PRR	b/Rouseville	1,000	Comp.
Op.	W.H. Daugherty & Son Refg. Co.	B&O	b/Petrolia	2,000	S&L
Op.	Franklin Creek Refg.Corp.	ERR	b/Franklin	1,000	S&L
S.d.	Franklin Leasing Co.	ERR	b/ do.	900	Comp.
Op.	The Freedom Oil Works Co.	PRR	b/Freedom	2,000	Comp.
Op.	Gulf Refg. Co.	PRR	a/Girard Point	33,000	*S&L
Op.	do.	P&OV,PC&Y,P&LE	b/Neville Island	7,500	*Skim.
Op.	Kendall Refg.Co.	B&O,ERR,PRR	b/Bradford	3,400	*Comp.
Op.	A.D.Miller Sons Co.	B&O,PRR	b/Pittsburgh	1,000	S&L
Op.	Mutual Refg. Co. (Sherwood Pet.Co.)	PRR	b/Warren	800	Comp.
Op.	Oil Creek Refg. Co.	NYC	b/Titusville	1,000	Comp.
S.d.	Penncrude Refg.Co.	PRR	b/Kennerdell	400	S&L
Op.	Penn Oil Products Refg.Co.	PRR	b/Eldred	5,000	*Comp.
Op.	Pennsylvania Refg. Co.	B&O	b/Karns City	2,000	Comp.
Op.	do.	NYC,PRR	b/Titusville	700	S&L
Op.	The Pennzoil Co.	ERR,NYC,PRR	b/(Rouseville b/(McClintock	8,000	*Comp.
Op.	The Pure Oil Co.	PRR,P&R	a/Marcus Hook	20,000	*Comp.
Op.	Pure Penn Refg.Co.	PRR	b/Clarendon	350	S&L
Op.	Quker State Oil Refg.Corp.	PRR	b/Emlenton	1,650	*Comp.
Op.	do.	P&N	b/Farmer's Valley	2,000	Comp.
Op.	do.	ERR.NYC,PRR	b/Oil City	1,800	Comp.
Op.	Sinclair Refg.Co.	PRR,P&R	a/Marcus Hook	20,000	*S&L
Op.	Starlight Refg.Co.	B&O	b/Karns City	300	Petro.
Op.	Sun Oil Co.	B&O,P&R,PRR	a/Marcus Hook	45,000	*Comp.
Op.	Superior Oil Works	PRR	b/Warren	500	Comp.
S.d.	Swan-Finch Refg.Co.	PRR	b/ do.	1,000	Comp.
Op.	The Texas Co.	PRR	c/Marcus Hook	1,500	Asph.
Op.	Tiona Refg. Co.	PRR	b/Clarendon	1,000	Comp.
S.d.	Tio-Penn Refg.Co.	PRR	b/Tiona	500	Skim.
Op.	Ultra-Penn Refg. Co.	B&O	b/Bruin	1,000	*Comp.
Op.	United Refg.Co.	PRR	b/Warren	2,000	Comp.
Op.	Valvoline Oil Co.	B&O	b/E. Butler	3,000	Comp.
Op.	do.	PRR	b/Warren	1,000	Comp.
S.d.	Viking Oil Corp.	PRR, TV	b/Clarendon	1,500	Comp.

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	PENNSYLVANIA Cont'd) a/ b/				
S.d.	Waverly Oil Works Co.	P&LE	b/Coraopolis	4,000	*Skim.
Op.	do.	PRR	b/Pittsburgh	1,000	*Comp.
Op.	Wolverine-Empire Refg.Co.	ERR,NYC	b/Reno	1,000	Comp.
Op.	do.	PRR	b/Tidioute	800	S&L
				258,250	
	RHODE ISLAND a/				
Op.	Standard Oil Co.of N.Y.(Inc)	NYNH&H	E. Providence	10,000	*SL&A
Op.	The Texas Co.	NYNH&H	Providence	1,500	Asph.
				11,500	
	SOUTH CAROLINA a/				
Op.	Standard Oil Co. of N.J.	ACL,SAL,So.	Charleston	6,000	*SL&A
				6,000	
	TENNESSEE c/				
Op.	Russell Producing Co.	So.	Bone Camp	75	Skim.
				75	
	TEXAS e/ i/				
Op.	Allstate Refg. Co.	I&GN	e/Thrall	2,500	Skim.
Op.	American Pet. Co.	Port Term.	i/Norsworthy	4,000	Skim.
S.d.	American Refg.Properties	FW&DC,MKT	e/Wichita Falls	6,000	*Skim.
S.d.	Apache Refg. Co.	----	e/Sunray	5,000	Skim.
Op.	Archer Refg.Corp.	Frisco	e/Megargel	1,000	Skim.
S.d.	The Arrow Refg.Co.	I&GN	e/Overton	2,500	Skim.
S.d.	Atlantic-Pacific & Gulf Refg. Co.	FW&DC	e/Wichita Falls	3,500	*Skim.
Op.	Beacon Oil & Refg.Co.	I&GN	e/Henderson	3,500	Skim.
Op.	Bell Oil & Gas Co.	Santa Fe	e/Pampa	6,500	Skim.
S.d.	Bi-State Refg. Co.	MKT	e/Burkburnett	500	Skim.
Op.	Bluebonnett Refg.Co.	Frisco	e/Brownwood	75	Skim.
S.d.	Bluebonnet Oil Refg.Co.	T&P	e/Wickett	4,000	Top
S.d.	Bobrose Oil Refg.Co.	MKT,SantaFe	e/Brownwood	1,000	Skim.
Op.	do.	SP	e/Luling	2,500	Skim.
Op.	Boone Refg. Co.(Inc.)	none	e/Arp	300	Skim.
S.d.	Burford Oil Co.	Santa Fe,T&P	e/Pecos	5,000	*Skim.
Op.	M.D.Carson Refinery	Frisco, Santa Fe	e/Brady	70	Skim
S.d.	Central Refg.Co.	I&GN	e/Henderson	10,000	Skim.
Op.	Col-Tex Refg.Co.	T&P	e/Colorado	10,000	*Skim.
Op.	Concho Refg.Co.	Santa Fe	e/San Angelo	100	Skim.
Op.	Conroe Refg. Co.	MoP	e/Conroe	250	Skim.
S.d.	Constantin Refg.Co.	I&GN	e/Overton	2,500	Skim.
Op.	Continental Oil Co.	MKT	e/Wichita Falls	5,000	*Skim.
Op.	Cosden Oil Co.	T&P	e/Big Spring	10,000	*Skim.
Op.	Crown Oil & Refg. Co.	Port Term.	i/Houston	10,000	*S&L
S.d.	The Dale Oil & Refg.Co.	FW&DC	e/Electra	4,000	Skim.
S.d.	Deepwater Oil Refineries (Inc.)	Port Term.	i/Houston	3,000	S&L

Status	Company	Railroad	Location	Daily capacity barrels	Type of plant
	TEXAS (Cont'd) e/i/				
Op.	Diamond Refg. Co.	I&GN	e/Overton	3,000	Skim.
Op.	Dixon Creek Oil & Refg.Co.	Santa Fe	e/Kings Mill	3,500	Skim.
Op.	East Texas Refg. Co.	I&GN	e/Henderson	6,000	Skim.
Op.	do.	T&P	e/Longview	6,000	*Skim.
Op.	Empire Oil & Refg.Co.	MKT,SantaFe	e/Gainesville	5,000	*Skim.
Op.	Exchange Pet. Corp.	MKT	e/Albany	400	Skim.
Op.	Falls Refg. Co.	FW&DC	e/Wichita Falls	2,500	Skim.
S.d.	Foster and Co.	MKT	e/Denison	400	Skim.
Op.	Gladetex Refg. Co.	T&P	e/Gladewater	700	Skim.
Op.	Gladewater Refg.Co.	T&P	e/ do.	1,000	Skim.
Op.	Grayburg Oil Co.	MKT,SP	e/San Antonio	2,000	*Skim.
S.d.	Great West Refg.Co.	T&P	e/Big Spring	5,000	Skim.
Op.	Gulf Refg. Co.	FW Belt	e/Fort Worth	1,000	*Skim.
Op.	do.	KCSo,SP	i/Port Arthur	125,000	*Comp.
Op.	do.	Santa Fe, T&P	e/Sweetwater	5,600	*Skim.
Op.	Houston Oil Co.of Texas	MoP	i/Viola	1,000	Skim.
S.d.	Howard County Refg.Co.	T&P	e/Big Spring	1,800	Skim.
Op.	Humble Oil & Refg.Co.	MoP,SP	i/Baytown	125,000	*S&L
S.d.	do.	WFS	e/Breckenridge	1,500	Top
Op.	do.	SP	e/Chilton	4,500	Top
Op.	do.	SP	i/Ingleside	15,000	*Skim.
S.d.	do.	Santa Fe	e/McCamey	15,000	*Skim.
Op.	do.	SP	e/Neches	5,000	Top.
Op.	do.	MoP,SP	e/San Antonio	4,500	Skim.
Op.	Iowa Park Prod.&Refg.Co.	FW&DC	e/Iowa Park	2,500	*Skim.
S.d.	Kent Refg.Co.	SP	e/Angus	3,000	Skim.
S.d.	do	SA&AP	e/Minerva	2,000	Skim.
Op.	Kilgore Refg. Co.	I&GN	e/Kilgore	1,500	Skim.
S.d.	LaSalle Pet. Co.	MKT	e/Burkburnett	3,000	*Skim.
Op.	W.B. Mackey Co.	T&P	e/Gladewater	1,000	Skim.
S.d.	Macmillan Pet. Corp.	Santa Fe	e/Borger	5,500	Skim.
Op.	Magnolia Pet. Co.	KCSo,SP	i/Beaumont	70,000	*Comp.
Op.	do.	St.L&SW,SP	e/Corsicana	4,000	Skim.
Op.	do.	MKT,St.L&SW, T&P	e/Fort Worth	4,500	*Skim.
Op.	do.	RI,SantaFe	e/ do.	2,600	*Skim.
Op.	do.	SP	e/Luling	5,000	*Skim.
S.d.	do.	KCSo	i/Magpetco	10,000	Skim.
Op.	Marathon Oil Co.	SP	e/Del Rio	2,500	Skim.
Op.	do.	MKT,St.L&SW, T&P	e/Fort Worth	5,000	*Comp.
Op.	Master Pet. Co.	MoP,St.L&SW	e/Waco	600	Skim.
Op.	Misko Refineries(Inc.)	Tex.Mex.	e/Mirando City	1,200	*S&L
Op.	Moutray Oil Co.	WV	e/Hawley	750	Skim.
Op.	Muenster Refg. Co.	MKT	e/Muenster	270	Skim.

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	TEXAS (Cont'd.) e/,i/				
Op.	Nolting Refg. Co.	T&P	e/Sweetwater	700	Skim.
S.d.	Norgold Refg. Co.	WF&S	e/Olney	800	Skim.
S.d.	O-Bar Refg. Co.	Santa Fe	e/Coleman	500	Skim.
Bldg.	Octane Oil & Refg. Co.	T&P	e/Chautauqua	1,400	Skim.
Op.	Olney Oil & Refg. Co.	WF&S	e/Olney	3,000	*Skim.
Op.	Oriental Oil Co.	Santa Fe,T&P	e/Dallas	3,500	*S&L
Op.	Overton Refg.Co.(Inc.)	I&GN	e/Overton	3,000	Skim.
Op.	Panhandle Refg. Co.	MKT.	e/Wichita Falls	5,000	*Skim.
Op.	Pasotex Pet. Co.	MNW,NM,SantaFe SP, T&P	e/El Paso	14,000	*Skim.
S.d.	Petroleum Refractionating Corp.	T&P	e/Longview	10,000	Skim.
Op.	Phillips Pet. Co.	RI,Santa Fe	e/Borger	25,000	*Skim.
Op.	Phoenix Refg. Co.	SA&AP	e/Pettus	600	Skim.
S.d.	do.	T&P	e/Eagle Ford	350	Skim.
Op.	Pioneer Oil & Refg. Co.	MoP	e/Somerset	2,000	S&L
Op.	Primrose Refg. Co.	MKT	e/Wichita Falls	3,000	Skim.
Op.	The Pure Oil Co.	KCSo.	i/Nederland	30,000	*Skim.
Op.	Republic Oil Refg.Co.	BRI,I&GN,MKT, Santa Fe,SP	i/Texas City	5,000	*Skim.
S.d.	Richardson Refg. Co.	T&P	e/Big Spring	6,000	*Skim.
Op.	Rio Grande Oil Co.	SP, T&P	e/El Paso	5,000	Skim.
Op.	J.Howard Samuell Refinery	Santa Fe	e/Coleman	250	Skim.
S.d.	San Angelo Refg.Co.	do.	e/San Angelo	1,000	Skim.
S.d.	Seymour Refg. Co.	MV	e/Seymour	250	Skim.
Op.	Shell Pet. Corp.	Port Term.	i/Houston	26,000	*Skim.
S.d.	Signal Refg. Co.	Santa Fe	e/Texon	500	Skim.
Op.	Simms Oil Co.	T&P	e/W.Dallas	4,500	*Skim.
Op.	Sinclair Refg. Co.	I&GN,MKT, Santa Fe,T&P	e/Fort Worth	4,000	Skim.
Op.	do.	SP, T&P	e/Gladewater	1,500	Skim.
Op.	do.	Port Term.SP	i/Houston	31,000	*S&L
S.d.	Slach Pet. Co.	T&P	e/Longview	2,000	Skim.
Op.	Southern Oil Refg.Co.	I&GN	e/Reed's Switch	2,500	Skim.
S.d.	Southland Refg.Co.	Frisco,WF&S	e/Olney	650	Skim.
Op.	Star Refg. & Prod. Co.	FW Belt	e/Fort Worth	1,500	*Skim.
S.d.	Stone Oil Co.	TC Term.	i/Texas City	3,000	*Skim.
S.d.	Superior Refg. Co.	T&P	e/Tiffin	1,500	Skim.
S.d.	Taxman Refg. Co.	MKT	e/Wichita Falls	2,500	*Skim.
Op.	Taylor Refg. Co.	I&GN, MKT	e/Taylor	4,000	Skim.
Op.	do.	St.L&SW	e/Tyler	15,000	*Skim.
Op.	The Texas Co.	FW&DC, SantaFe	e/Amarillo	4,000	*Skim
Op.	do.	SP	e/El Paso	1,500	*Skim.
Op.	do.	SP	i/Houston	20,000	*Skim.
Op.	do.	KCSo, SP	i/Port Arthur	60,000	*Comp
Op.	do.	KCSo.	i/Port Neches	20,000	Asph
Op.	do.	MKT,SP	e/San Antonio	3,000	*Skim.
Op.	do.	Santa Fe,T&P	e/W. Dallas	16,000	*Skim.

Status	Company	Railroad	Location	Daily capacity, barrels.	Type of plant
	TEXAS (Cont'd.) e/ i/				
S.d.	Texas Mexican Oil & Refg. Co.	I&GN, Tex-Mex.	e/Laredo	500	Lube
Op.	Texas Pacific Coal & Oil Co.	none	e/Caddo	1,000	Top
Op.	do.	St.L&SW	e/Fort Worth	3,000	*S&L
Op.	Texas Pet. Prod.Co.	MoP	e/Somerset	1,500	Skim.
S.d.	Tonkawa Pet. Corp.	T&P	e/Pyote	2,500	Skim.
Op.	Waggoner Refg. Co. (Inc.)	FW&DC	e/Electra	6,000	Skim.
S.d.	Western Oil Corp.	MKT	e/Burkburnett	3,000	Skim.
Op.	Wickett Refg. Co.	T&P	e/Wickett	1,200	Skim.
Op.	H.F. Wilcox Oil & Gas Co.	Santa Fe	e/Pampa	2,500	Skim.
S.d.	Will C. Young	WF&S	e/Archer City	250	Skim.
				935,065	
	UTAH g/				
S.d.	Diamond Oil Co.	UP	Virgin	500	Skim.
Bldg.	Jensen Oil Refg.Co.	D&RGW, OSL	Ogden	1,000	*Skim.
Op.	Utah Oil Refg. Co.	BE, D&RGW,OSL	N.Salt Lake City	6,000	*Comp.
S.d.	Utah Parks Pet.Co.	None	Virgin	300	Skim.
				7,800	
	VIRGINIA a/				
Op.	The Texas Co.	N&PB	Norfolk	1,500	Asph.
				1,500	
	WEST VIRGINIA				
Op.	Carbide & Carbon Chemicals Corp.	C&O	S. Charleston	1,600	*Skim.
Op.	Elk Refg. Co.	B&O	Falling Rock	3,000	S&L
Op.	Ohio Valley Refg.Co.	B&O	St. Marys	2,000	*Comp.
Op.	The Pure Oil Co.	C&O	Cabin Creek Jct.	3,500	*Comp.
Op.	Standard Oil Co. of N.J.	B&O	Parkersburg	5,500	*Comp.
Op.	Tri-State Refg. Co.	B&O,C&O,N&W	Kenova	2,000	*Skim.
				17,600	

Status	Company	Railroad	Location	Daily capacity, barrels	Type of plant
	WYOMING g/				
Op.	G. F. Bock & Son	CB&Q	Clay Spur	50	Skim.
Op.	California Pet. Corp.(Utah)	none	LaBarge	300	Skim.
Op.	Continental Oil Co.	CB&Q, C&NW	Glenrock	4,000	*Skim.
Op.	Eclipse Oil & Refg. Co.	none	Newcastle	40	Skim.
S.d.	Egaso Operating Co.	CB&Q	Osage	750	*Skim.
Op.	Gillette Refg. Co.	CB&Q	Gillette	100	Skim.
Op.	Goshen Oil & Refg. Co.	CB&Q	Torrington	250	Skim.
Rebldg.	Hole's Pedro Refinery	CB&Q	Pedro	100	S&L
S.d.	Lusk Oil & Refg. Co.	C&NW	Lusk	36	Skim.
Op.	The Midwest Refg. Co.	CB&Q, C&NW	Casper	65,000	Comp.
Op.	do.	do.	Greybull	13,000	*S&A
Op.	do.	UP	Laramie	5,000	*Skim.
Op.	Northwestern Pet.Co.	CB&Q	Osage	300	Skim.
Op.	Producers & Refiners Corp.	UP	Parco	8,000	*Skim.
Op.	The Texas Co.	CB&Q, C&NW	Casper	7,000	*Skim.
Op.	The Texas Co.	CB&Q	Cody	3,000	*Skim.
Op.	White Eagle Oil Corp.	CB&Q, C&NW	Casper	6,000	*Skim.
Op.	Wyoming Gas & Oil Co.	none	Osage	100	Skim.
				113,026	

SUPPLEMENTARY LIST OF PLANTS

This group comprises a number of small plants for which the information was incomplete.

State	Company	Location	Daily capacity, barrels
Colorado	Mountain States Refg. Co.	Orchard	200
Kentucky	Pilot Knob Refg. Co.	Crail Hope	100
New Mexico	Desert Refg. Co.	Artesia	120
	Pitts Refinery	Seven Lakes	50
Oklahoma	Huckins Refg. Co.	Earlsboro	500
	Kiowa Refg. Co.	Gotebo	100
	Chas. E. Knox Refinery	Covington	200
	The Pilgrim, Inc.	Kingston field	75
South Dakota	Yellowstone Pet. Co., Inc.	Lead	1,000
Texas	Belknap Refg. Co.	Newcastle	150
	Echotex Refg. Co.	Echo	300
	Goss Bros	Rising Star	50
	Lovco Refg. Co.	Wheat field	225
	Mentone Oil & Refg. Co.	Arno	1,000
	Nacogdoches Refg. Co.	Nacogdoches	500
	Peterson-Woodruff's Refinery	Harlingen	1,000
	Geo. W. Stephenson	Floresville	40
	Wilson & Swain	Woodson	50
Wyoming	Calmonica Oil Co.	La Barge	50
	4 C Syndicate	Big Muddy	50
	Interstate Oil & Refg. Co.	Mule Creek	50
	Oreana Oil Refg. Co.	La Barge	50

I. C. 6642

October, 1932

Department of Commerce

United States Bureau of Mines
Scott Turner, Director

INFORMATION CIRCULAR

MINING LAWS OF NEWFOUNDLAND

BY

E. P. Youngman

I.C. 6642
October, 1932.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

MINING LAWS OF NEWFOUNDLAND[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper is one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the right of American citizens to explore for minerals and to own and operate mines in various foreign countries. This interpretation of the mining laws of Newfoundland was prepared from such of the colony's statutes (see "Appendix") as are still in force and from a monograph upon the subject published by the Imperial Institute of London.[3] Applicable English acts were not included.

INTRODUCTION

At the time of the preparation of the monograph upon the mining legislation of Newfoundland,[4] by the Imperial Institute of London, the existing local statutory law (as distinct from case laws and the applicable English acts) consisted of the following legislation:

1. Chapter 129 of the consolidated statutes, entitled "Of Crown Lands, Timber, Mines and Minerals," as amended by the Crown lands act, 1928.

2. Chapters 131 and 132 of the consolidated statutes (acts relating to mines regulation and rewards for discovery of minerals, respectively).

3. Crown lands act, 1918, as amended by the crown lands (amendment) act, 1921.

4. The Labrador Act, 1927.

5. The Crown royalties act, 1927.

6. Crown lands act, 1928, together with rules and regulations issued thereunder.

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1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6642."

2 Rare metals and nonmetals division, U. S. Bureau of Mines.

3 Imperial Institute (London), The Mining Laws of the British Empire and of Foreign Countries; Newfoundland: Vol. 11, London, 1930, 56 pp.

4 See footnote 3.

Since the publication of that monograph, the Crown lands act of 1932 repealed the legislation listed as Nos. 1, 3, and 6, leaving Nos. 2, 4, and 5 of the foregoing acts still in force. The statutory acts now applicable to mining in Newfoundland may be assumed to be the following:

1. The Crown lands act of 1930.[5]

2. The Department of Agriculture and Mines Act of 1929.[6]

3. Chapters 131 and 132 of the consolidated statutes (acts relating to mines regulation and rewards for discovery of minerals, respectively).

4. The Labrador Act, 1927.

5. The Crown royalties act, 1927.

6. Income tax act, 1929, the general income tax law, applying to profits from mining.

7. Customs smelter act, 1929, for the encouragement of the industry.

The most recent legislation passed for the encouragement of home smelting is the customs smelter act of 1929. The bounties act of 1903 provided for a bounty on iron. Various acts encouraged the copper industry (see copper smelting acts of 1910 and 1911). The coal development acts also are of but general importance; they simply empower the governor to make special grants to coal-developing companies (see coal development act of 1919).[7]

All citations in this paper, unless otherwise designated, are to the Crown lands act of 1930.

RIGHTS OF FOREIGNERS

Foreigners are not excluded from mining rights in Newfoundland, as the Crown lands act of 1930, in article 56, provides that "any person or any company incorporated under the laws of Newfoundland" shall be entitled to a miner's permit, upon the payment of a fee of $5. The miner's permit is the basis for all subsequent rights.

CLASSIFICATION OF MINERALS

Minerals shall mean all valuable deposits of gold, silver, platinum, iridium or any of the platinum group of metals, mercury, lead, copper, iron, tin, zinc, nickel, aluminum, antimony, arsenic, barium, bismuth, boron, bromine, cadmium, chromium, cobalt, iodine, magnesium, manganese, molybdenum, phosphorus, plumbago

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5 Crown lands act, 1930, An Act Respecting Crown Lands, Timber, Minerals, and Water Power: July 14, 1930 (21 Geo. v, chap. 15).
6 Department of Agriculture and Mines Act, June 1, 1929 (20 Geo. v, chap. 20).
7 See footnote 3.

potassium, sodium, strontium, sulphur (or any combination of the aforementioned elements with themselves or with any other elements), asbestos, emery, mica, and mineral pigments.

Limestone, marble, clay, or any building stone shall not be considered as mineral within the meaning of this act. (Art. 2--f.)

MINERAL LANDS

Permit holders are granted rights upon (a) all Crown lands within the colony and (b) all lands the mines, minerals, or mining rights whereof have been reserved by the Crown in any disposition of such lands, which are not at the time under staking as a mining claim that has not lapsed or been abandoned, cancelled, or forfeited, and which may not have been withdrawn or reserved by an order in council from prospecting or staking. (Art. 56--b.)

The Governor in Council may direct that the mines and minerals in certain reserved land be worked on behalf of the Crown. (Art. 62--2.) Any officer of the Crown or any assistant of such an officer making a discovery of valuable mineral upon any land open to searching, prospecting, and staking out as a mining claim shall stake out and record a parcel thereof, of the size and form of a mining claim, on behalf of the Crown. No proceeding shall be necessary except to plant posts and blaze lines as provided with respect to a mining claim. On post No. 1 shall be noted the words "staked out for the Crown," and within the time limit fixed by the act the claim shall be recorded with the Minister. (Art. 63--1 and 2.)

No mining claim shall, except with the consent of the Governor in Council and upon such terms as to him may seem just, be staked out upon any lands (a) belonging to the Newfoundland Railway, (b) reserved or set apart as a town site by the Crown, (c) granted to any person for and actually laid out as a town site, and (d) in occupation and use by any department of the public service for the purposes of such department. (Art. 59.)

Notwithstanding that the mines or minerals therein have been reserved to the Crown, no person shall search or prospect for minerals upon any land used as a garden, orchard, nursery, plantation, or pleasure ground, or upon which crops that may be damaged by such prospecting are growing, or in that part of any land upon which is situated any spring, reservoir, dam, or water works, or any public or private building, or cemetery except with the consent of the owner or lessee of the surface rights or by order of the Governor in Council and upon such terms as to him may seem just. (Art. 60.)

AUTHORITIES

The Department of Agriculture and Mines Act of 1929 created the Department of Agriculture and the Department of Mines, both under an official entitled "Minister of Agriculture and Mines," appointed by the Governor in Council. Article 4 of this act enumerates among other duties of the Department of Mines the execution of the laws relating to (a) Crown lands and (b) mines and minerals.

The Crown lands act of 1930 provides that the Governor in Council shall prescribe rules and regulations as to the forms and modes of application for licenses, leases, and grants, and generally for the purpose of carrying out the act, and may from time to time repeal, amend, or alter such rules and regulations (to come into effect after one month's previous publication in the Newfoundland Gazette and in two other newspapers of the colony). (Art. 182.)

All applications for leases, licenses, or grants shall be made to the Governor in Council. (Art. 183.)

All applications for and all duplicates of leases, licenses, or grants shall be recorded in the office of the Minister of Agriculture and Mines. (Art. 183.)

DISCOVERY OF MINERAL

In accordance with chapter 132 of the consolidated statutes, any person registered as the original discoverer of any mineral shall be entitled to receive $1,000 from the funds of the Colony, provided the deposit shall be developed or operated, operation to mean that at least 50 men shall have been continuously employed in actual mining for at least one year.

The procedure to be followed in registering a mineral discovery is as follows:[8]

> It shall be lawful for any person who shall make any discovery of minerals in this Colony, at the time of making application for a licence for the same or without making any such application, to file in the office of the Minister of Agriculture and Mines a claim in writing, verified by affidavit, setting forth that he is the first and original discoverer of such mineral, what said mineral is, and as accurately as possible the situation of the deposit. The Minister of Agriculture and Mines, immediately upon the filing of such claim shall give public notice in the ROYAL GAZETTE and one other newspaper setting forth briefly the facts contained in said claim and the name of the claimant, and calling upon all persons who may dispute such claimant's right as first or original discoverer to give notice to his Department of any objection thereto within sixty days thereafter. If at the expiration of the said period of sixty days no such objections are received at the Department, the claimant shall be deemed to be the true first and original discoverer, and his name and the location of his discovery shall be registered in a book to be kept in the said Department called "The Register of Mineral Discoveries." If any such objections are received at the said Department, then immediately upon the expiration of the said period of sixty days, the Minister shall summon all parties making such objections, and the claimant, by notice in writing, to appear before him, and after hearing such of the said parties as shall appear in obedience to said summons, either separately or together, shall report thereon to the Governor in Council, who shall determine who is the true first or original discoverer and cause his name and the location of the discovery to be registered in manner aforesaid. The decision of the Governor in Council shall be final.

8 Consolidated Statutes, of the Discovery of Minerals, Chap. 132.

PROSPECTING PERMIT

General

The prospecting permit (or miner's permit) is, in general, the basis for all mining rights (as only the holder thereof may stake a claim and only a claimant may obtain a mining grant or, with respect to quarries, petroleum, gas, coal, or salt, a lease). The miner's permit may be issued to any person or to any company incorporated in Newfoundland, for a fee of $5. (Art. 56--a.)

The miner's permit does not give an exclusive right to prospect for minerals until the permittee shall have complied with the provisions of the law with respect to the staking of claims, as set forth in article 64. (Art. 61.) The holder of a miner's permit desiring to have the exclusive right to bore for petroleum, natural gas, coal, or salt for one year must likewise comply with the provisions with respect to staking, set forth in articles 64 and 108. (Art. 108.)

Manner of Prospecting

A prospector may explore by any means necessary to prove the existence, value, or extent of minerals, either by surface or by subterranean prospecting or by excavation, provided that it shall be done with a view to obtaining a mining location, and provided further that no greater quantity of mineral or ore shall be removed than shall be necessary as samples. (Art. 57.)

Reservations for Geophysical Prospecting

Any person desiring to prospect by electrical means or by what are known as geophysical methods (involving the use of electrical, gravitational, vibrational, or other instrumental methods applied on or near the surface), as distinguished from ordinary methods, may obtain from the Governor in Council a reservation (not to exceed 25 square miles) for three years, with no right of renewal. (Art. 107--a and e.)

Every applicant for such a reservation must prove that he is not connected directly or indirectly with any other applicant or holder of a permit. (Art. 107--b.)

Such a reservation is not transferable without the consent of the Governor in Council. At any time within the year a permittee may abandon, by written notice to the Minister, such areas (reckoned in units of 0.5 square mile) as he may deem fit. (Art. 107--c and h.)

The sum of $5,000 (in cash or an approved surety bond) for each square mile of the area reserved shall be deposited by the applicant within two months of the time of making the reservation, as a security that he will expend that sum in electrical or other geophysical prospecting or in drilling or excavation.

At the end of each year it shall be lawful for the Minister to return to the applicant so much of the sum deposited as the Auditor General shall certify that he is satisfied the applicant has spent. Any balance remaining unexpended out of the cash deposit or the amount of the bond after repayments at the end of the third year shall be forfeited to the Crown. (Art. 107--f, g and i.)

A prospector by geophysical methods may stake out a mining claim and obtain the same mining rights as the holder of any other license. (Art. 107--j.

STAKING

A permit holder, either for himself or for another permit holder, may stake out a mining claim on any land open to prospecting. He may work the claim or he may transfer his interests. If surface rights have been granted or leased by the Crown, compensation must be made. (See section entitled "Rights of Surface Owners.") (Art. 58.)

Staking is made the condition for the receiving of further rights, with the following exceptions:

1. If the location or locations referred to in the application are covered by the sea or public tidal waters.

2. If the location or locations applied for are situated on an island off the coast of Newsoundland or Labrador and the area of the location or locations applied for is equal to or greater than the area of the island. (Art. 168.)

A staked mining claim shall be a square of 40 acres, being 20 chains (1,320 feet) on each side. (Art. 64--e.)

A mining claim shall be laid out with boundaries running north and south and east and west, astronomically; and the measurements thereof shall be horizontal; and the boundaries shall extend downwards vertically on all sides. (Art. 64--e.) An irregular portion of land lying between land not open to staking or bordering on water may be staked out with boundaries coterminous thereto, but the staking shall conform as nearly as possible to the prescribed form and shall not exceed the prescribed area. (Art. 64--f.)

Provisions with respect to the erecting and marking of boundary posts and related matters, under the ordinary miner's permit, are covered in detail by articles 64 and 65.

The area of land included under a boring permit shall not exceed 640 square acres in extent; the form shall be rectangular; and the boundary lines thereof shall be due north and south and east and west, astronomically. (Art. 108--3.) Additional provisions with respect to the staking of land under a boring permit are covered by article 108 (1)-(a) and article 64.

MINING RIGHTS

General

The staking out of a mining location or the filing of an application for or the recording of a mining claim makes the permit holder merely a licensee of the Crown and confers no right other than that of applying for a certificate of record, under which (as a tenant of the Crown) the permit holder must perform the required assessment work before he may obtain a fee-simple grant. (Art. 73 and 101.) The principal steps between the staking out of a mining claim and the receiving of a grant are the obtaining of a certificate of record of the mining claim and the performance of the required assessment work.

Mining Claims

Within 60 days of the staking out of a mining claim, the applicant therefor shall file with the Minister an application, including the following (art. 67):

1. An outline sketch or plan of the claim, showing the corner posts and the witness posts, together with their distance from each other.

2. In the case of unsurveyed territory, the general locality of the claim, including at least two bearings in relation to natural features, the length of the outlines, and the reason for any irregularity, if any exists.

3. The day and hour the claim was staked out and the date of the application.

4. A fee of $10, for which an official receipt shall be given.

5. An affidavit as to the accuracy of the statements.

Certificate of Record

When 60 days have elapsed since the recording (in accordance with article 68) of the application for a mining claim, the Minister shall issue a certificate of record, provided there is no dispute standing. (Art. 70.)

A certificate of record, which is evidence that all the provisions of the mining act, except those relative to required work, have been fulfilled, makes the holder thereof a tenant of the Crown until he shall have obtained a fee-simple grant, upon the completion of the five years' assessment work. (Art. 71.)

Assessment Work

The recorded holder of a mining claim shall (within 5 years immediately following the recording) perform drilling, electrical or other geophysical prospecting, stripping or opening up of mines, sinking shafts, or other actual mining operations (constructing houses or roads or like improvements not to be considered mining work) to the extent of 200 days' work of not less than 8 hours a day, as follows: At least 30 days' work within 3 months immediately following the recording of the claim and not less than 40 days' work in each of the remaining 4 years, provided that in any one of the 5 years 10 additional days' work shall be done to make up the total. The work may be done in a shorter period, the excess of one year to be credited to the subsequent year. (Art. 84--1 and 2.)

A license holder may perform all the work required with respect to not more than six contiguous mining claims held by him on one or more of such claims; and the report to be filed by him shall certify the claim or claims upon which the work was performed and the claims upon which it is to be applied. (Art. 84--7.)

A money equivalent at the rate of $3 for a day's work will be accepted in case a claim holder has been unable to do the required work. (Art. 89.)

Boring with a diamond drill shall count at the rate of two days' work for every foot of boring. Work by a drill operated by compressed air shall count as work at the rate per day of three days' work for each man necessarily employed upon each drill. Electrical or other geophysical prospecting shall count as work at the actual cost or such lesser rate as may be fixed by the Minister, subject to appeal to the Governor in Council. (Art. 84--3.)

In computing the first installment of work, the period between November 16 and May 15 (both inclusive) shall not be included; but this shall not extend the time for any subsequent installment. (Art. 85.) The Minister may extend the time because of the illness or death of the claim holder. (Art. 86.)

In case a claim is held jointly, each holder shall contribute in proportion to his interest. Should one holder default, upon application of any other holder and upon notice to and after hearing all persons interested, the judge may make an order vesting the interest of the defaulter in the other coowners or in any one of them upon such terms and conditions and in such proportions as he may deem just. (Art. 87--1.)

If the Minister is satisfied, from the reports, that the prescribed work has been done, he may grant a certificate therefor, or he may first order an inspection or investigation. (Art. 84--5.) If a certificate has been issued in mistake or default, the judge shall have the power to revoke it, upon application by the Crown or by an official of the department or by any person interested. The decision of the judge as to the due performance of work is final. (Art. 84--6.)

Abandonment and Forfeiture

Abandonment.- A permit holder may, by giving written notice to the Minister of his intention, abandon a mining claim, which becomes open to prospecting and staking on the thirty-second day after the posting of the notice of abandonment. (Art. 90.)

Noncompliance by a permit holder with any requirement as to the time or manner of staking out or recording a mining claim is deemed to be an abandonment; and the claim becomes open to prospecting and staking. (Art. 91.)

The recorded holder of a certificate of record, upon abandoning a claim, may remove (within six months after abandonment or within any period allowed by the judge) machinery, chattels, personal property, or extracted ore or minerals. (Art. 74.)

Forfeiture.- At any time before a fee-simple grant has been issued, all interests of the holder of a mining claim shall be forfeited upon the following conditions (Art. 92):

1. If the permit has expired and has not been renewed.

2. If, without the consent in writing of the Minister or judge, or for any purpose of fraud or deception or other improper purpose, the holder removes or causes to be removed any stake or post forming part of the staking out of a claim, or for any such purposes changes or effaces or causes to be changed or effaced any writing or marking upon any such stake or post.

3. If the prescribed work is not done.

4. If any report (under subsection 4 of section 84) with respect to the work done, is not made to the Minister.

Relief Against Loss of Rights.- When rights have been lost or forfeited, the judge, within three months after the entry of or the record of cancellation by the Minister, upon such terms as he deems just, may make an order relieving the person in default from the forfeiture or loss of rights. If forfeiture has occurred because of the expiration of a permit, the claim holder shall obtain a special renewal license, upon payment of twice the prescribed license fee; if forfeiture has occurred because of failure to file reports of work, the holder shall file the prescribed report and pay a special fee of $10. (Art. 93.)

Mining Grants

The holder of a mining claim, upon compliance with all the requirements of the mining act, including work assessment, is entitled to a grant, in fee simple application for which shall be made within one month from the date upon which all work on the mining claim is required to be performed. (Art. 101.)

Unless otherwise expressly stated, such a grant issued in pursuance of the mining act vests in the grantee all title of the Crown in such lands and all mines and minerals therein. (Art. 103.)

A survey by a surveyor approved by the Minister, at the expense of the applicant, must be made before a grant may issue. Details with respect to the making of the survey, the report to be made thereon, and correction of the area (if necessary) are given in articles 104, 105, and 106.

PETROLEUM, GAS, COAL, AND SALT RIGHTS

Petroleum, natural gas, coal, and salt rights are exercised under boring permits and boring leases. (Art. 108 and 109.)

Boring Permits

Any permit holder (holder of a miner's license) may obtain the exclusive right to prospect for petroleum, gas, coal, or salt upon any land open for prospecting and staking by conforming with the staking provisions of article 108 (sections a, b, c, and d) and article 64. (See section of this paper entitled "Staking.")

A boring permit is issued for one year, with the right of renewal for one additional year. (Art. 108--1 and 5.)

A permittee shall enter upon the area granted within two months from the issue of the permit and during the term thereof shall expend in actual boring, sinking, driving, or otherwise searching for petroleum, etc., a sum not less than $2 an acre. (Art. 108--4 and 5.)

A boring permit is transferable if the consent of the Governor in Council is indorsed thereon. (Art. 108--6.)

Boring Leases

General.- A boring lease may be granted to the holder of a boring permit upon proof that the permittee has discovered petroleum, gas, coal, or salt in commercial quantities. (Art. 109--1.) A lease confers the right upon the lessee to dig, bore, sink, drive, or otherwise search for and obtain, raise, and remove any or all of these substances,--all other minerals to be reserved to the Crown. Such a lease shall not prevent another permit holder from staking out a mining claim (subject to compensating the lessee) upon the leased land and obtaining a grant in fee simple therefor,--the grant, however, to reserve the petroleum, gas, coal, and salt in or under such land. (Art. 109--3.)

Duration.- A lease may run for 10 years and may be renewed for a further term of 10 years. (Art. 109--1.)

Conditions.- An annual rental of $5 an acre, payable in advance, must be paid, and an annual expenditure of not less than $2 an acre must be made, under the original lease. The renewal lease shall be at such rental as may be agreed upon or as may be provided for by the statutes or regulations. (Art. 109--1.)

Survey.- A lease shall not issue until a plan made by an approved surveyor has been filed in triplicate with the Mining Department. (Art. 109--4.)

Forfeiture.- The forfeiture of a boring lease shall result for non-payment of rent or for default in making the required expenditures or for failure to comply with any of the terms and conditions of the lease, provided that relief may be had by the payment of all arrears within 90 days after they become payable. (Art. 109--2.)

QUARRYING LEASES

The Governor in Council may grant leases of land for quarrying[9] purposes. No lease for quarrying shall convey any right to coal, petroleum, natural gas, or minerals within or under the land covered by the lease or any exclusive right or privilege with respect to any lake, river, spring, stream, or other body of water within or bordering on or passing through the land covered by the lease. (Art. 26.)

An applicant for a quarrying lease shall give notice in the Newfoundland Gazette for one month prior to the application of his intention to apply.

A quarrying lease shall be for a term of not more than 99 years. It shall comprise an area of not more than 10 acres, at a rental of not less than $5 an acre a year. (Art. 25.)

A lessee shall commence work within two years from the date of the lease and shall continue effective operation during the term of the lease.

Should the lessee, for the space of five years, intermit operations, his lease shall be void, and the land therein shall revert to the Crown without suit or proceeding. (Art. 25.)

DREDGING LEASES

The Governor in Council may make regulations for the issuing of leases authorizing the holders thereof to dredge in any river, stream, or lake in, on, or flowing through Crown lands or the bed of which belongs to the Crown, for the purpose of recovering any valuable mineral. Every order in council with respect thereto shall take effect from the date of its first publication in the Newfoundland Gazette. (Art. 110--1.)

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9 A quarry for the purpose of the mining act is a working for the obtaining of limestone, granite, slate, marble, gypsum, marl, gravel, sand, clay, or other building stone, or volcanic ash. (Art. 26.)

A dredging lease is granted for a term of 10 years, with the right of renewal for a further period of 10 years.

Annual rental shall be not less than $20 a mile in length of the body of water in question.

The Governor in Council may make whatever provisions are necessary to protect all public interests, including the driving of logs and timber and navigation. (Art. 110--2.)

RIGHTS OF SURFACE OWNERS

The holder of a mining lease or grant or of a boring permit is entitled to specified surface rights and easements, but the owner, lessee, or occupant of the land is entitled to proper compensation for all damage to the surface occasioned by prospecting for minerals, staking out a mining claim or a boring area, or carrying on mining operations. In default of agreement, the amount, manner, and time of compensation shall be determined by the judge, whose decision is final, except that when the amount exceeds $1,000, appeal may be made to the full court. (Art. 99--1.)

The judge or the Minister may reduce the area of a mining claim staked out where surface rights have been granted, sold, or leased, should he decide that less than the prescribed area is sufficient. (Art. 100.)

TRANSFERS, ETC.

Every application for a mining claim and every other application and every transfer or assignment of a mining claim or of any right or interest acquired under the provisions of the mining act shall contain or have indorsed thereon the place of residence and the post-office address of the applicant, transferee, or assignee, or resident of Newfoundland upon whom service may be made. (Art. 75.)

Among the conditions attached to transfers, etc., are the following:

1. Another person resident in Newfoundland may be substituted as the person upon whom service may be made by filing, in the office in which the application, transfer, or assignment is recorded, a memorandum setting forth the name, residence, and post-office address of that person. (Art. 75--3.)

2. Notice of a trust (express, implied, or constructive) relating to any mining claim not granted in fee simple shall not be entered on the record or be received by the Minister. (Art. 76--1.) No person dealing with a claim holder described as a "trustee" is obligated to inquire as to his powers; but nothing in this provision shall relieve a claim holder that is in fact a trustee from liability as between himself and any other person, mining partnership, or company for whom he is a trustee. (Art. 76--2 and 3.)

ROYALTIES

A royalty of 5 per cent of net profits obtained through the sale of minerals "gotten in or from" a mining claim or grant is payable December 31 of each year during the continuance of the claim or grant (or within 60 days thereafter) to the Minister of Agriculture and Mines for the use of the colony. (Art. 111--a.) Net profits shall be ascertained by the holder or grantee of or under a mining claim or grant by deducting certain specified expenses from the gross price received for the minerals during the year. (Art. 111--b.)

TAXES, RENTS, AND FEES

Income Tax[10]

"The ordinary income tax law applies in the case of profits made from mining activities, and such income tax ranges between 5 per cent and 8 per cent, varying with the income and commencing at $1,500 and ending at incomes exceeding $6,000, to which must be added in the case of incomes exceeding $6,000 a super tax, varying from 2 per cent of the amount by which the income exceeds $6,000 but does not exceed $8,000 to the maximum of 35 per cent of the amount by which the income exceeds $100,000.

"Corporations pay at a different rate, namely, 8 per cent on incomes exceeding $5,000, but are not liable to super taxes. In the case of mining concerns, however, the assessor in determining the income derived from mining and from oil wells makes such an allowance for the exhaustion of mines and wells as he deems fit and fair."[11]

Rents

The annual rental for a lease for boring oil, gas, coal, or salt is $5 an acre, payable in advance. (Art. 109--1.)

The annual rental for a dredging lease shall not be less than $20 a mile in length of the river, stream, or lake in question, and it shall be payable in advance. (Art. 110--2.)

The annual rental for a quarrying lease shall not be less than $5 an acre. (Art. 25.)

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10 Income Tax Act, 1929, sec. 4 (1) and (5)-(i).
11 See footnote 3.

Fees

The following fees are fixed in the law:

1. Miner's permit, $5. (Art. 56--a.)

2. Application for claim that has been staked, $10. (Art. 67--1.)

3. Boring permit and renewal, $100 each. (Art. 108--1-c and 5.)

4. Geophysical prospecting license, a sum equal to the amount that would be chargeable for one year for the area if taken out in the form of an ordinary mining license. (Art. 107--d.)

5. Certified copy of writ of execution, $1. (Art. 83--7.)

6. Relief against forfeiture of mining rights,--the amount being dependent upon cause of forfeiture. (Art. 93.)

General

No grant, lease, or license shall issue but on the payment of the sum of not less than $1 for the document of title, which sum shall be paid in stamps affixed to the document. All other fees, prices, or rentals shall be paid in cash. (Art. 180.)

No grant or lease shall issue to any person, in respect to which any price or rental is payable under this act, until such price or rental is paid in full, unless in this act otherwise provided. (Art. 181.)

MINING PARTNERSHIPS

A mining partnership may be formed by 2 or more persons (not exceeding 9) and 1 or more persons and a company,--each person to be at least 18 years of age. (Art. 112--1.)

The application, or certificate, to be signed personally or by an attorney, shall set forth: (a) The name, address, and occupation of each partner; (b) the partnership name; (c) the total number of shares; (d) the number of shares owned by each partner; (e) the date for the commencement and the date for the termination of the partnership; (f) the name, address, and occupation of some person residing, or of a company having its head office, in Newfoundland authorized (in writing annexed to or forming part of the certificate) to act as agent of the partnership. (Art. 112--1.)

A mining partnership when recorded (by the filing of the certificate with the Minister) shall be entitled to a miner's permit. (Art. 112--2 and 3.)

Further details are covered by subsections 4 and 11 of article 112.

DISPUTES

General

There is no special court in Newfoundland charged with the determination of location or other disputes arising between the holders of mining titles and other holders or the general public. Save as appears below, all mining disputes or disputes arising out of the holding of mining titles (location disputes, encroachment actions, and actions for trespass) are determined in the ordinary courts, in accordance with general principles. Ordinary procedure is controlled by and is subject to the provisions of the judicature act.[12]

The Crown lands act, 1930, provides that "no action concerning mining lands shall lie, nor shall any other proceeding be taken, in court as to any matter or thing arising under this act, whether before or after issue of the fee-simple grant or involving the interpretation of the provisions thereof or as to the rights acquired or alleged to have been acquired thereunder, or as to any other matter or thing involving any right or claim under this act, unless such matter shall first have been brought before a judge in chambers on originating summons; and upon such summons it shall be lawful for the judge either to direct an action to be taken, or to move the summons into court, or to determine the matter summarily." (Art. 113--a.) Details will be found in subsections (b) to (f) of article 113. Procedure with respect to specific disputes are covered in articles 69, 99, 100, 111, 162, and 170 of the Crown lands act of 1930 and in articles 6 and 22 of Chapter 131 (of the regulation of mining).

ARBITRATION

An arbitration shall be conducted as follows: The arbitrators shall be three, one person appointed by each of the contending parties, the third to be the Minister of Agriculture and Mines (or some one appointed by writing under his hand); and the award of any two of the arbitrators shall be final, provided, however, that the interested parties may appeal therefrom to the Supreme Court, upon due notice to the opposite party within one month from the publication of the award. (Art. 162.)

In an award the arbitrators, or the umpire, shall determine (Art. 171):

1. Whether the lands, etc., sought are necessary for the working of the mineral locations.

2. Conditions with respect to commencement and completion of the various works and their distances from existing mines, buildings, works, ore bodies, or mineral seams and their natural and necessary extensions,--in all cases providing that such ore bodies and mineral seams may not be entered, except that the right may be granted to the applicant to sink upon the land a vertical shaft through the ore seams and intervening strata, until the shaft shall reach the strata to be traversed.

12 See footnote 3.

3. Works to be provided for the protection of the property and employees of the person whose lands or locations are affected.

4. Amount of compensation for lands, easements, etc.

5. Amount of deposit to be made by the applicant as security against damages to the person whose lands or locations are affected.

So much of the "Judicature Act" as refers to arbitration shall apply mutatis mutandis to arbitrations under this act. (Art. 172.)

PENALTIES

In any case where no other penalty is specifically provided, any person committing an offense against any of the provisions of the mining act shall be liable to a fine not to exceed $50, "to be recovered by the Governor in Council, which date shall not be earlier than summarily." (Art. 187.)

Interrupting, molesting, or hindering a survey or knowingly or wilfully destroying or altering survey markings carries the liability to conviction before a stipendiary magistrate and to a fine not exceeding $25 or three months' imprisonment, without prejudice to any civil remedy that any surveyor or other party may have against the offender. (Art. 186.)

Any one guilty of irregular or improper staking out of land or of failing to record a staking within the prescribed time shall not thereafter be entitled to again stake such land or any part thereof or to record a mining claim, unless he shall notify the Minister in writing that he acted in good faith and shall pay a fee of $20. (Art. 65--1.)

Any owner, agent, or manager proved guilty of an offense agai . the mining regulations (chapter 131 of the consolidated statutes) shall be liable to a fine not to exceed $80; and any person other than an owner, agent, or manager shall be liable to a fine of $8. (Art. 12 and 13 of chap. 131.)

Any person removing, destroying, or defacing any stake lawfully planted by any other person shall be subject, on summary conviction, to a fine not to exceed $100 and may be ordered to pay the cost of restoring or replacing such stake. (Art. 65--3.)

MINING REGULATIONS

The Governor in Council shall prescribe rules and regulations as to the forms and modes of applications for licenses, leases, grants, and generally for the purpose of carrying out the provisions of the mining act and may repeal, amend, or alter such rules and regulations, which shall come into operation after one month's previous publication in the Newfoundland Gazette and in two other newspapers in the Colony. (Art. 182.)

Chapter 131 of the consolidated statutes[13] treats of safety, ventilation, inspection, accidents and reports thereof, mineral returns, and related matters. It empowers the Governor in Council to make general rules for the proper sanitation of the mines and for the storing and transport of explosives,--the rules to have the force and effect of law when published in the Royal Gazette.

The rules incorporated in Chapter 131 are relatively simple; but provision is made for the drafting of special rules for any particular mine.

> In the first place the special rules are prepared by the owner, agent, or manager of the mine and are transmitted to the Government engineer for approval by the Governor in Council. If approved, no further question arises; if, however, approval is made contingent upon the incorporation of amendments, the owner, agent, or manager may take objection to the proposed amendments, whereupon the dispute is referred to arbitration. The rules that are established, if the matter is referred to arbitration, are such rules as are established by the arbitrators' award.[14]

Article 19 of chapter 131 provides that no boy under the age of 13 and no girl or woman of any age shall be employed in or allowed to be for the purpose of employment in any mine below ground.

> The mechanics' lien system is in operation. The relevant act is the mechanics' lien act (chapter 215 of the consolidation of 1916), which, however, has a somewhat narrow application in the case of miners.
>
> A liability is imposed upon employers, not unlike that created by the (British) employers liability act, 1880, by the liability of employers for injuries to workmen act (chapter 211 of the consolidated statutes), and a system of workmen's compensation is established by chapter 212 of the consolidated statutes, as slightly amended by the workmen's compensation acts of 1919 and 1926.[15]

MINING RIGHTS IN LABRADOR

Mining rights in Labrador are placed under the provisions of the Crown Lands Acts of Newfoundland by the Labrador Act of 1927, by excepting the issuing of licenses, leases, or grants of mineral lands from the general provision that no land in Labrador belonging to Newfoundland shall be granted save by an act of the Legislature of the colony.[16]

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13 Chapter 131 of the Consolidated Statutes, Of the Regulation of Mines.
14 See footnote 3.
15 See footnote 3.
16 An Act to Govern the Granting of Lands and Rights in Labrador: Chap. 11, Labrador Act, Sept. 6, 1927.

CUSTOMS SMELTER ACT[17]

The customs smelter act of 1929, the latest of such acts for the encouragement of home smelting, states in the preamble that, although there exist in various parts of Newfoundland deposits of copper and other ores, of the known deposits none is large enough to warrant the erection of a smelter.

Under the act, the Governor (Sir John Middleton) entered into an agreement with the Newfoundland Mines and Smelters (Ltd.), in June, 1929, article 7 of which provides that the company shall have the exclusive right and franchise for a period of 10 years from and after the first day of January, 1935, to carry on in Newfoundland the business of smelting, refining, manufacturing, roasting, reducing, treating, and/or preparing for market ores and mining products, including lead, copper, zinc, silver, gold, and other minerals and their constituent residual and by-products, under any or all the chemical, electrical, and/or other methods now in use or which may hereafter be brought into use; provided that the owner of any mine shall have the right to smelt or treat the ore or products of his or its own mine, in his or its own smelter.

Article 9 of the agreement exempts from taxes and duties goods and articles admitted to the colony connected with the company's operations for a period of 10 years from the date of the commencement of construction.

Article 11 of the agreement states that the company shall be permitted to export its metals and finished products free of all taxes, duties, royalties, or assessments of what kind soever for a period of 10 years from the first day of January, 1935. Exemption does not apply to ores or raw products of any mine to whomsoever belonging, and nothing shall be held to exempt the company from any liability to pay any income tax or corporation tax or any like tax now imposed or which may hereafter be imposed.

Article 8 of the agreement provides for the arbitrament of disputes by the Public Utilities Commission (created by Act. 20, Geo. v, chap. 9), from whose decision appeal may be made to the Supreme Court.

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17 Customs Smelter Act, 1929, An Act Relating to the Establishment of a Custom Smelter in Newfoundland, passed June 1, 1929; 20 Geo. v, chap. 22: Acts of the General Assembly of Newfoundland, 1929, St. John's, 1929, pp. 82-95.

APPENDIX

Newfoundland Statutes Affecting Mining

1860 An act to make provision for the disposal and sale of certain crown lands and for the granting of licenses and leases of mineral lands.

1872 Consolidated statutes, chap. 47, "of mines and minerals," royalties abolition act, 1872.

1880 Crown lands act, 1880.

1884 Crown lands act, 1884.

1891 Crown lands act, 1884, amendment act, 1891.

1892 Consolidated statutes, chap. 13, "of crown lands, timber, mines and minerals."

1898 Mining leases act, 1898.

1899 Crown lands act, 1899.

1901 Crown lands act, 1901.

1903 Bounties (on iron) act, 1903.

Crown lands act, 1903.

1906 Crown lands amendment act, 1906.

Mines (regulation) act, 1906.

1908 Mines (regulation) act, 1908.

1910 Copper smelting act, 1910.

Discovery of minerals act, 1910.

Dredging of rivers act, 1910.

1911 Copper smelting act, 1911.

Crown lands act, 1911.

1916 Consolidated statutes, chap. 129, "of crown lands, timber, mines and minerals."

1916 Consolidated statutes, chap. 131, "of the regulation of mines."

Consolidated statutes, chap. 132, "of the discovery of minerals."

1918 Crown lands act, 1918.

1919 Coal development act, 1919.

1921 Crown lands (amendment) act, 1921.

1927 Crown royalties act, 1927.

The Labrador Act, 1927.

1928 Crown lands act, 1928.

1929 Department of Agriculture and Mines act, 1929.

1929 Customs smelter act, 1929.

Income tax law, 1929.

1930 Crown lands act, 1930.

I. C. 6639 June, 1932

Department of Commerce

UNITED STATES BUREAU OF MINES
Scott Turner, Director

INFORMATION CIRCULAR

ECONOMIC FACTORS INFLUENCING THE DOMESTIC DEMAND FOR GASOLINE

PART I - REVENUE MOTOR BUSES

BY

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ECONOMIC FACTORS INFLUENCING THE DOMESTIC DEMAND FOR GASOLINE. PART I - REVENUE MOTOR BUSES[1]

By H. A. Breakey[2] and E. B. Swanson[3]

Introduction

An analysis of the economic factors influencing the domestic demand for gasoline is essential to the establishment of adequate bases for the calculation of trends and the forecasting of future demand, to which the oil industry recently has given particular attention. Furthermore, a thorough analysis should result in the segregation of gasoline demand into its component parts. Such a division, of particular interest to marketers of gasoline, would indicate the ratio between the motor fuel normally supplied through the service, or "filling," station and that supplied through direct delivery to the consumer. It is quite possible that the expansion of service-station facilities may have resulted from an over-emphasis of the individual car owner, served through stations, as a user of gasoline, and that sufficient attention has not been given that portion of demand resulting from needs other than those of the privately-owned automobile.

Increased Use of Gasoline

A review of gasoline consumption during the period, 1920-1931, reveals that a definite correlation between motor-car registrations and motor-fuel demand was present during the first five years. The annual increase in car registrations was closely in accord with the yearly increase in gasoline consumption. Both nearly doubled during the five years, but the average yearly gasoline demand did not vary materially per motor vehicle, being around 10.5 or 11 barrels during each year. Beginning with 1925, however, the demand for gasoline increased more rapidly than did the registration of motor vehicles (see Table 1). In other words, the trend-curve of gasoline consumption no longer paralleled that of motor-vehicle registrations, as it did during the years 1920-1924, but began to diverge upwards, continuing

2/ Assistant economic analyst, petroleum economics division, U. S. Bureau of Mines.
3/ Chief economist, petroleum economics division, U. S. Bureau of Mines.

its course during the seven years 1925-1931. As a result, the average gasoline demand per motor vehicle showed a yearly increase of nearly a barrel per vehicle, the consumption per vehicle being 50 per cent greater in 1931 than in 1924.

Table 1. - Motor-vehicle registrations and motor-fuel demand

Year	Registered motor vehicles, Thousands	Domestic demand for motor fuel, thousands of barrels	Average demand per motor vehicle, barrels	Index Numbers	
				Motor vehicles	Motor-fuel demand
1920	9,232	102,937	11.15	100	100
1921	10,463	108,644	10.38	113	106
1922	12,238	129,383	10.57	133	126
1923	15,092	158,720	10.52	163	154
1924	17,594	187,022	10.63	191	182
1925	19,937	226,329	11.35	216	220
1926	22,001	264,391	12.02	238	257
1927	23,133	299,818	12.96	251	291
1928	24,493	332,033	13.56	265	323
1929	26,501	375,999	14.19	287	365
1930	26,524	394,800	14.88	287	384
1931	25,814	403,455	15.63	280	392

This method of calculating gasoline demand (dividing the total demand by the number of motor vehicles registered) has been used regularly by those engaged in economic studies of the oil industry. When the calculated average annual demand began to indicate a consistent gain, in explanation thereof, attention was directed toward the extended mileage of improved highways, stimulating tourist traffic; the larger number of closed cars in use, facilitating all-weather travel; the increased power of the modern automobile; and other factors which would contribute to the increased demand for gasoline by the individual car owner. While each of these factors would influence consumption, it has been recognized that the final results of the calculation were inconsistent with the actual facts and that the actual gasoline consumption of the average automobile has not increased at the rate indicated. It is apparent that certain factors, not present in the earlier years, entered into the more recent history of gasoline demanded. The increased use of motor trucks, buses, and taxicabs has been of particular significance. (Fig. 1.) Such vehicles consume from 3 to more than 15 times as much gasoline annually as the average private automobile, and an increase in their number is correspondingly significant.

In the method of calculating gasoline demand outlined, no allowance is made for this difference in unit consumption, nor that of airplanes, tractors, locomotives, and other consuming units not included in the registration of motor vehicles. Consequently, crediting the total increase in gasoline consumption to the average automobile obviously is incorrect and leads to fictitious conclusions.

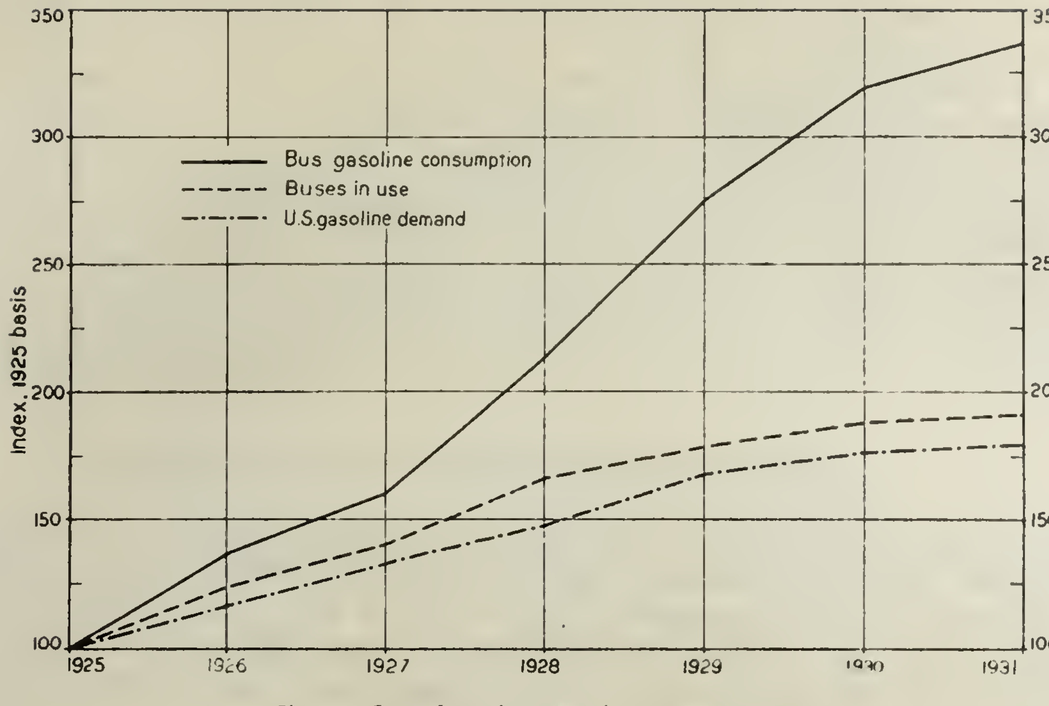

Figure 1.- Trend of gasoline consumption by buses, 1925-1931

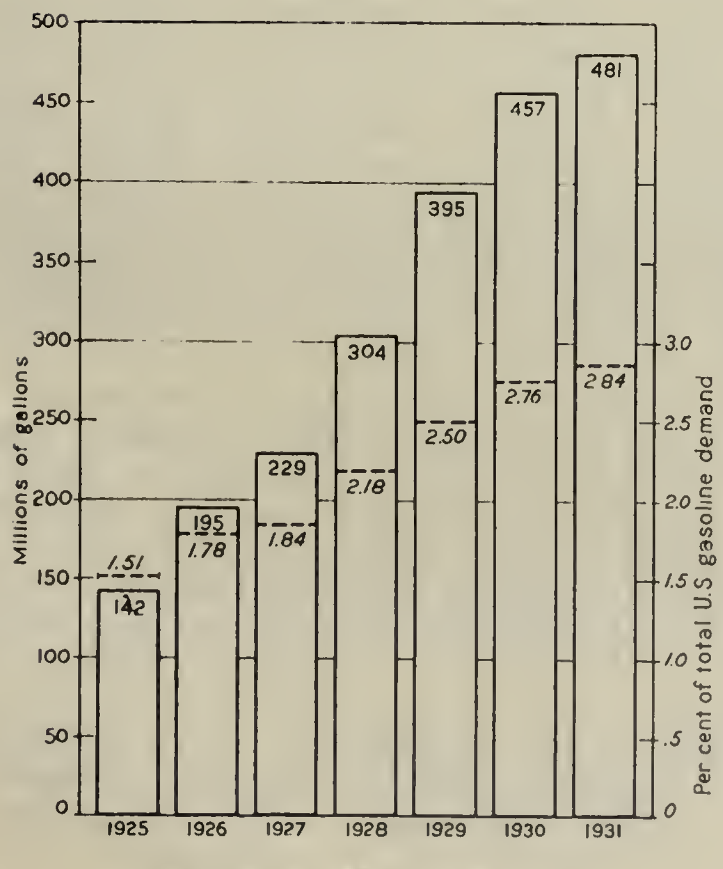

Figure 2.- Gasoline consumption by buses, 1925-1931

Figure 3.- Monthly gasoline consumption by intercity and city buses, 1928-1931

As one phase of its studies of the economics of the mineral industries, the Bureau of Mines has outlined a series of reports, of which this is one, intended to analyze certain of the factors which have contributed to the increased use of gasoline. In a previous paper[4/] certain data were presented on the consumption of gasoline for miscellaneous purposes, such as road and general construction, manufacturing, cleaning, and the demand by tractors, airplanes, locomotives, and motor boats. The influence of the revenue motor bus on gasoline consumption is discussed in this report. The complete co-operation of 34 companies operating city buses and 29 companies operating intercity buses, furnishing representative data for all sections of the country, is acknowledged gratefully.

The Bus as a Factor in Gasoline Consumption

As a factor in the determination of gasoline consumption, the revenue (common carrier) motor bus was almost twice as important in 1931 as in 1925, accounting for nearly 3 per cent of the total domestic gasoline demand in 1931, as compared with 1.5 per cent of the 1925 demand. (Fig. 2.) Quantitatively, the calculated gasoline demand of revenue buses has increased from 3,391,000 barrels in 1925 to 11,468,000 barrels in 1931.

Table 2. - Gasoline consumed by revenue motor buses

Year	No. of Buses[1/]	Gasoline consumption (barrels)			Index	Per cent of United States demand
		City[2/]	Intercity	Total		
1925	23,800	1,202,000	2,189,000	3,391,000	100	1.51
1926	29,300	1,683,000	2,966,000	4,649,000	137	1.78
1927	33,450	2,087,000	3,371,000	5,458,000	161	1.84
1928	39,650	2,714,000	4,534,000	7,248,000	213	2.18
1929	42,650	3,321,000	6,073,000	9,394,000	275	2.50
1930	44,550	3,458,000	7,427,000	10,885,000	318	2.76
1931	45,400	3,621,000	7,847,000	11,468,000	336	2.84

1/ 1928-1931 Bus Transportation, February, 1932; 1925-1927, from Editor of Bus Transportation, 330 West 42nd Street, New York City.
2/ Sightseeing and irregular included in city buses.

In relation to the number of motor vehicles registered, the number of revenue buses has shown a consistent gain, increasing from 0.12 per cent of the total in 1925 to 0.17 per cent in 1931. This relatively small proportion undoubtedly has led to the underestimation of the importance of the revenue bus in gasoline consumption. The continually increasing size of the bus and its more intensive use, as evidenced by the greater number of miles traveled per bus, has increased its importance as a user of gasoline far in excess of its increase in numbers.

4/ Breakey, H. A., and Swanson, E. B., Gasoline-Tax Refunds as a Source of Economic Information: Paper presented at North American Gasoline Tax Conference Denver, Colo., September, 1931.

Although the number of buses recorded was nearly twice as large in 1931 as in 1925, the total gasoline consumption was 3-1/3 times as much, indicating that the average consumption per bus increased correspondingly. This situation results from the fact that intercity buses have registered increasing annual mileage and that both city and intercity buses have recorded decreased mileage per gallon of gasoline. The net result is that the average consumption of gasoline by intercity buses has increased from 6,061 gallons in 1924 to 11,585 gallons in 1931 and that of city buses from 6,616 gallons in 1924 to 9,176 gallons in 1931. In terms of miles per gallon, the intercity bus has dropped from 7.94 miles in 1924 to 4.62 miles in 1931, and the city bus from 5.56 miles in 1924 to 3.88 miles in 1931.

Table 3. - Annual bus data, 1924-1931

Year	Miles per bus		Gallons per bus		Miles per gallon	
	Intercity	City	Intercity	City	Intercity	City
1924	48,150	36,749	6,061	6,616	7.94	5.56
1925	46,507	38,272	6,578	7,434	7.07	5.15
1926	44.942	37,425	7,551	7,401	5,95	5.05
1927	40,782	37,120	7,044	7,776	5,79	4.77
1928	40,561	37,498	7,247	8,685	5,60	4.31
1929	47,375	37,410	9,708	9,376	4,88	3.99
1930	52,826	35,779	11,201	9,191	4.72	3.89
1931	53,563	35,590	11,585	9,176	4.62	3.88

Revenue buses have been considered under two classes in this report--city and intercity--and so far as possible the statistical data have been segregated correspondingly (fig. 3). The city bus, with its frequent stops, its regular route, and its peak loads during rush hours, necessitating the idling of some of the equipment during the day, gets considerably less mileage per gallon of gasoline, travels less miles per year, and has a different seasonal variation in gasoline consumption than the intercity bus.

The City Bus

The outstanding feature in the statistics of city-bus operation is the decrease in the mileage obtained per gallon of gasoline (fig. 4). This decrease has been brought about by the larger type of buses used. While the miles per gallon of gasoline has decreased 31 per cent, or from 5.56 miles per gallon in 1924 to 3.88 miles per gallon in 1931, the number of buses with seating capacities of more than 25 in use by electric railway companies has increased from 38 per cent in 1925 to 68 per cent in 1931. The average seating capacity for buses in use by electric railways has risen from 27.4 in 1925 to 30.0 in 1931. As the average number of miles traveled per city bus has remained fairly constant, the decreased mileage obtained per gallon of gasoline has resulted in an increase in total gasoline consumption. The average annual gasoline consumption per city bus has increased from 6,616 gallons in 1924 to 9,176 gallons in 1931.

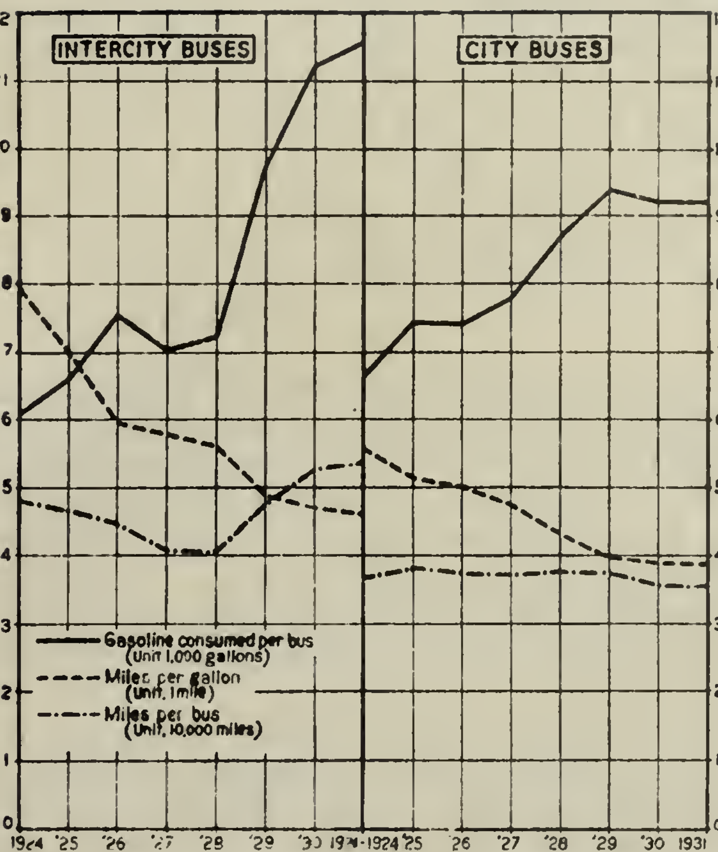

Figure 4.- Comparative data, intercity and city buses, 1924-1931

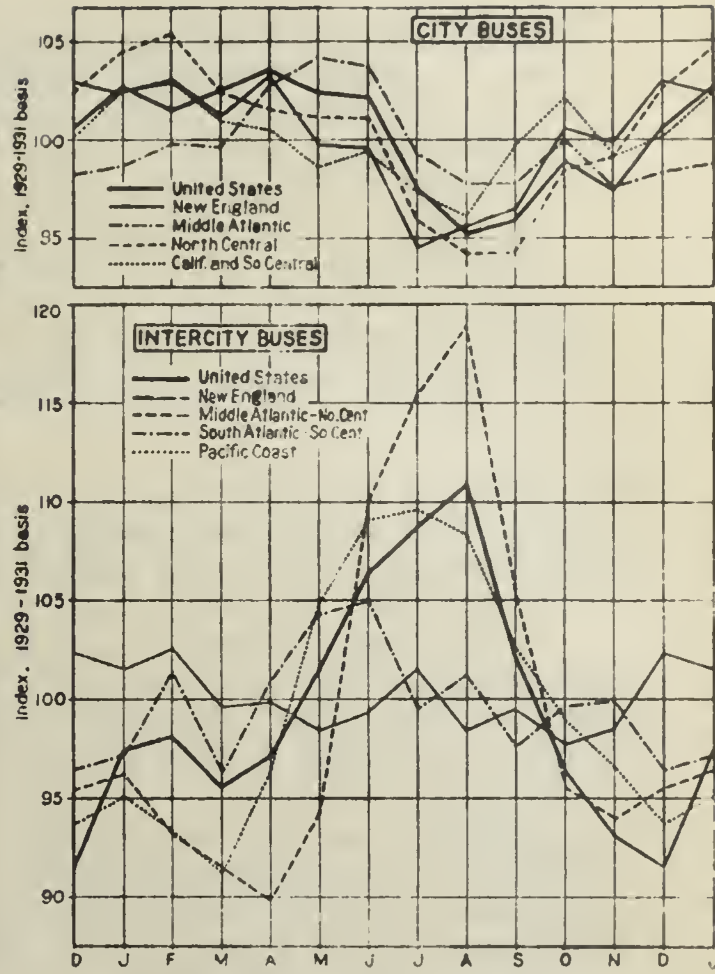

Figure 5.- Seasonal variation in bus gasoline consumption, by regions

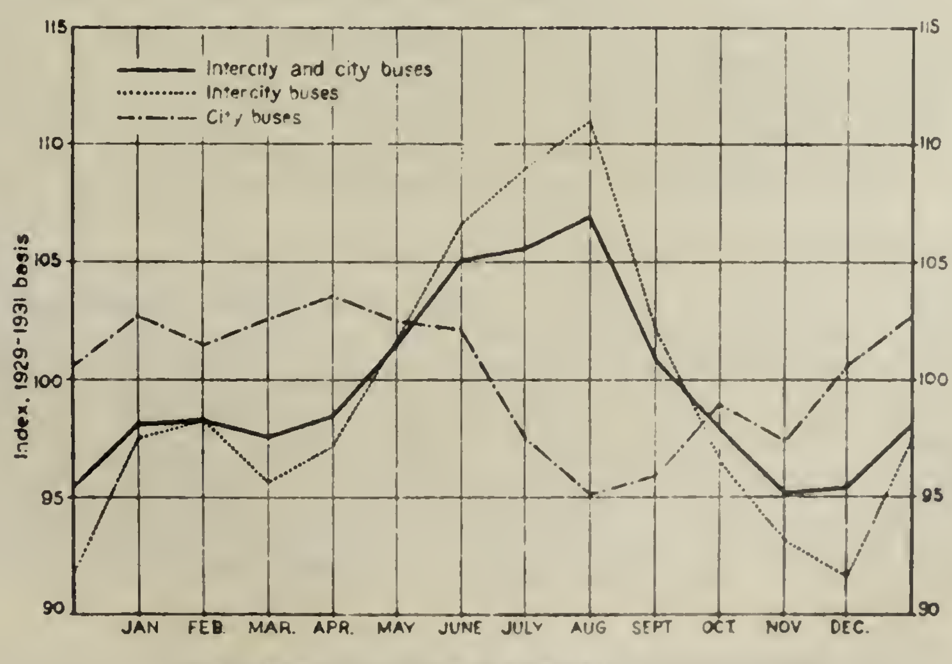

Figure 6.- Seasonal variation in gasoline consumption by intercity and city buses

The average seating capacity of bus bodies manufactured during the past few years should indicate the probable immediate trend in the sizes of buses. The average capacity per bus increased from 27.8 in 1927 to 31.7 in 1930 and then declined to 29.6 in 1931. This decrease in the average seating capacity of buses manufactured in 1931 may be accounted for principally by the increased output of buses in the 25 to 28 seating capacity range. It is possible that the change reflects the increasing sentiment against large buses. Matters of taxation also may be of influence. In Kentucky, the tax on buses is graduated up to 1 cent per mile for 26 to 29 passenger buses and then is increased to 3 cents per mile for buses with a seating capacity of 30 or more passengers.

An analysis by various sections of the country does not show a uniformity in trends (see Table 4). The average number of miles traveled by city buses in the Middle Atlantic section shows a slight upward trend, the highest figure being 36,607 miles in 1931, compared with an 8-year average of 35,911 miles. The number of miles traveled per gallon of gasoline decreased yearly from 5.96 in 1924 to 3.63 in 1931, and the gasoline consumed per bus increased each year from 5,969 gallons in 1924 to 10,099 gallons in 1931, which for the years 1930 and 1931 was contrary to the experience for the United States as a whole.

In the North Central area, gasoline consumption per bus has remained fairly constant around a 7-year average of 8,716 gallons per year. From 1925 to 1929 there was an upward trend in gasoline consumption, with the exception of 1926. The falling off during 1930 and 1931 is consistent with the national experience. The number of miles traveled by the average city bus declined yearly from 41,868 in 1925 to 34,604 in 1931. This is the only section of the country which showed a consistent decline in bus miles.

All sections of the country reported a decrease in the miles obtained per gallon of gasoline, but the decline has been greater in some than in others. In the Middle Atlantic section it decreased from 5.96 miles in 1924 to 3.63 miles in 1931, while it decreased in the North Central area from 4.95 miles in 1925 to 4.02 miles in 1931, but touched a low of 3.96 miles in 1930. The South Central area had the highest mileage per gallon of gasoline of any section of the country, probably reflecting the use of a smaller-sized bus.

In the operation of city buses, the period of heavy consumption comes in the first half of the year, reaching a peak in April, declining sharply during the summer months, with August as the low point for the year. (See Table 5.) The reasons given for the summer decline are the departure of people from the cities on vacations and for residence at summer homes, loss of patronage by school children, increased use of private automobiles, and increased walking during the pleasant weather. During the period from 1924 to 1928, June stood out as the most important month for gasoline consumption, but there has been a downward trend which has leveled its importance to that of the preceding months.

The various sections of the country are uniform in their summer decline in gasoline consumption, each one dropping off sharply beginning with June,

and all of them recovering again in the fall (fig. 5). California and the South Central sections start their recovery in September, but the North Central area lags until October before turning upward. The seasonal index for the North Central area from 1929-1931 shows an earlier up-turn and is more pronounced than that for the 7-year period from 1925-1931; it also is more pronounced than the seasonal variations for city buses in other sections of the country.

The seasonal index for the Pacific Coast-South Central area is somewhat similar to the North Central area, but the seasonal index for the Middle Atlantic area is distinctly different from the other two. After the fall recovery in October, the consumption again falls off, and it is not until April that a distinct improvement is shown. The peak consumption comes during the months of April, May, and June, and the 1929-1931 index does not show as great a decline in gasoline consumption as the indexes for the other sections of the country.

Of communities in the United States with more than 10,000 population, those depending entirely upon buses for local transportation increased from 189 in 1929 to 259 in 1931; those using combined bus and street-car service increased from 377 in 1929 to 414 in 1931, while those without local bus service decreased from 397 in 1929 to 309 in 1931.5/ Dependence solely upon buses for local transportation is confined almost entirely to communities within the 10,000 to 50,000 population range, while nearly all of the communities above that range have combined the use of buses with the existing street-car service. The bulk of the communities without local bus service fall within the 10,000 to 25,000 population range. Of the 14,335 buses operated in cities of over 25,000 population at the beginning of 1932, 10,655 were owned by electric railways or former electric railways.6/

Intercity Buses

Intercity bus operations of the present period differ from those of the past not only in improved equipment but also in improved operation. Instead of the small company operating over a few miles or at best a few hundred miles of route, the recent tendency has been for these small companies to merge into larger ones covering several States. There is one which is international in scope, covering practically all of the United States and operating in Canada also.

Because of the fact that most of the intercity bus companies in the North Central and Middle Atlantic areas have gone through some sort of merger during the past few years, statistics for these areas are incomplete for the earlier years of the study. However, the statistics which have been received for companies operating prior to 1929, and comparison with other studies, indicate that the larger units operate their buses with a greater annual mileage than did the older and smaller companies.

5/ Bus Transportation,--: New York, February, 1931, p. 71; Feb., 1932, p. 65.
6/ Transit Journal,--: January, 1932, p. 27.

The wider scope of operation, together with the larger buses now being used, has combined to increased the 1931 annual unit consumption of gasoline by intercity buses to almost double that recorded for 1924.

The New England area not only had the lowest annual bus mileage, but this mileage has increased but very slightly, and the miles-per-gallon does not show the wide variance between 1924 and 1931 that might be expected from the trend of the buses in other sections of the country. (See Table 6.)

On the Pacific Coast the annual mileage declined until 1928, but beginning with 1929 the trend has been upward. The gasoline consumption per bus, determined by the larger type of buses as well as the miles traveled, follows roughly though not consistently the trend of the miles per bus, showing a considerable increase in 1930 and 1931. The actual gasoline consumed by buses, however, shows a distinctly downward trend during these two years, which probably reflects the influence of the use of fewer buses because of consolidations and mergers of bus companies.

Because of the shortness of the period covered, and the unusual conditions prevailing during the past three years, it is difficult to determine from the figures shown for the other sections of the country, what trend does exist in annual mileage. However, since these figures represent the newer consolidations, and show a high mileage when compared with the older operators, it might fairly be assumed that the trend has been upward in these sections. One company averaged 92,306 miles per bus in 1931. Four out of five of these companies showed a greater number of miles per bus in 1931 than in 1930. The company reporting a reduced bus mileage credited the reduction to the rearrangement of routes among subsidiaries and highway improvements. The opening of the New York Avenue cut-off to the Baltimore Pike in Washington, D. C., reduced the bus distance to Baltimore by 4 miles each way for two buses each making eight round trips a day, or a saving of 64 miles a day for each of these buses.

The seasonal variation of gasoline consumption by intercity buses is different from that of city buses, with the exception that both reach a low point in the early winter months. (See Table 7.) The intercity buses reach a second low in March and April, which is the peak of consumption for city buses. Likewise, the variation from month to month is considerably greater for intercity buses than for city buses (fig. 6).

The bus systems of New England area are nearer the city type than the intercity. This probably reflects bus operations in a densely populated suburban area, which, while of the intercity class, take on some of the characteristics of the city type of operation.

In both the Pacific Coast section and the Middle Atlantic-North Central sections the low point of gasoline consumption is reached during the month of April, but in the Pacific Coast section there is very little change in the months from November to April. In the Middle Atlantic-North Central area the gasoline consumption for the months of March and April declines considerably from the winter gasoline consumption. The peak consumption in the Pacific

Coast section comes during July, while in the Middle Atlantic-North Central area it comes in August.

There seems to be practically no change in the seasonal variation for the New England and Pacific Coast areas for the past three years from what it was for the period 1924-1931, but in the Middle Atlantic-North Central section buses have consumed a greater proportion of gasoline in the summer months during these recent years, while the spring decline has been advanced to include February.

The various sections of the country are uniform in their summer decline in gasoline consumption, each one dropping off sharply beginning with June, and all of them recovering again in the fall. California and the South Central sections start their recovery in September, but the North-Central area lags until October before turning upward. The seasonal index for the North Central area from 1929-1931 shows an earlier up-turn and is more pronounced than that for the 7-year period from 1925-1931, and is more pronounced than the seasonal variations for city buses in other sections of the country.

Purchase of Gasoline

Gasoline required for the operation of buses is purchased usually on annual contracts, although some purchases are made on the open market. Payment for gasoline purchased on contract usually is based on the prevailing tank-wagon quotation, although some contracts are written at a fixed price. A sliding scale, with a price graduated according to the amount of gasoline taken, is another basis for payment.

Some attempt has been made to put the bus companies in a more effective position for contracting their gasoline requirements by getting them to purchase through State bus associations. This might benefit small operators, but the plan does not appear to have met with much favor. Some of the objections met are that certain bus companies favor the use of a particular brand of gasoline; that the price of gasoline is such that the distributors could not give a better price to an association than is given to an individual company. Certain large companies report that their purchases are of such quantities that there would be no advantage to them to join other companies in their contracts.

The large interstate operators have their gasoline delivered to various points where it is convenient to reservice their buses. Some operators stated that they attempt to have deliveries in each State proportionate to the mileage traveled therein, so that the gasoline tax paid will be divided among the States in proportion to the use of roads.

The smaller intercity companies and the city companies usually have only one or two storage sites for the gasoline, located at the center of their operations. The buses carry sufficient gas to be able, in most cases,

to make a round trip without refilling their tanks. The city buses, having an opportunity to refill more often than the intercity buses, do not carry a great amount of gasoline, their capacity ranging from about 30 to 70 gallons. Gasoline usually is supplied each time the bus comes to the garage.

The gasoline-carrying capacity of intercity buses ranges from 35 to 160 gallons. The 80-gallon tank appears to be the largest, and buses with a larger gasoline capacity usually carry two tanks. A 160-gallon capacity, even with only 3 miles to the gallon, would permit a bus to run nearly 500 miles without refilling.

Summary

1. The revenue motor bus is a factor of increasing importance in the calculation of prospective motor-fuel demand, accounting for nearly 3 per cent of the 1931 domestic gasoline consumption, as compared with 1.5 per cent of the 1925 demand.

2. The increased gasoline demand results largely from the gain in motor-fuel consumption per bus rather than from an increase in the number of buses operated. The average gasoline consumption by intercity buses increased from 6,061 gallons in 1924 to 11,585 gallons in 1931, while that of city buses has increased from 6,616 gallons in 1924 to 9,176 gallons in 1931.

3. Although the annual mileage traveled by the average bus has increased, the enlarged gasoline demand has been due principally to the decreased mileage obtained per gallon of gasoline consumed. The use of larger buses is a major factor in the increased gasoline consumption per bus-mile.

4. The monthly gasoline demand by the city bus does not vary as widely as that of the intercity bus. The use of the intercity bus for vacation travel contributes to the increased summer demand for gasoline.

5. The factors of motor bus gasoline demand analyzed in this report indicate that further increases may be anticipated.

Table 4. - City-bus data 1/

AVERAGE MILES TRAVELED PER BUS

Year	New England	Middle Atlantic	North Central	South Central	Pacific Coast	Total United States
1924	27,084	35,585	-	-	42,559	36,749
1925	30,688	36,084	41,868	-	41,392	38,272
1926	28,108	35,134	41,022	-	41,760	37,425
1927	29,049	34,612	40,510	36,362	41,702	37,120
1928	29,005	36,502	39,717	37,472	44,134	37,498
1929	32,145	36,603	38,356	38,921	44,851	37,410
1930	32,205	36,159	35,125	38,352	45,487	35,779
1931	31,455	36,607	34,604	37,898	43,988	35,590

GALLONS OF GASOLINE CONSUMED PER BUS

Year	New England	Middle Atlantic	North Central	South Central	Pacific Coast	Total United States
1924	5,489	5,969	-	-	7,160	6,616
1925	5,725	6,830	8,457	-	7,764	7,434
1926	5,893	6,830	8,155	-	8,606	7,401
1927	6,397	6,929	8,762	5,958	8,762	7,776
1928	6,947	9,057	8,835	7,627	9,439	8,685
1929	8,719	9,652	9,328	8,172	10,669	9,376
1930	8,833	9,732	8,864	7,888	10,775	9,191
1931	8,911	10,099	8,612	7,237	10,752	9,176

MILES TRAVELED PER GALLON OF GASOLINE

Year	New England	Middle Atlantic	North Central	South Central	Pacific Coast	Total United States
1924	4.93	5.96	-	-	5.94	5.56
1925	5.36	5.28	4.95	-	5.33	5.15
1926	4.77	5.14	5.03	-	4.85	5.05
1927	4.54	5.00	4.62	6.10	4.76	4.77
1928	4.18	4.03	4.50	4.91	4.68	4.31
1929	3.69	3.79	4.11	4.76	4.20	3.99
1930	3.65	3.72	3.96	4.86	4.22	3.89
1931	3.53	3.63	4.02	5.25	4.09	3.88

GALLONS OF GASOLINE USED PER BUS-MILE

Year	New England	Middle Atlantic	North Central	South Central	Pacific Coast	Total United States
1924	0.2028	0.1678	-	-	0.1684	0.1799
1925	.1866	.1894	0.2020	-	.1876	.1942
1926	.2096	.1946	.1986	-	.2062	.1980
1927	.2203	.2000	.2165	0.1639	.2101	.2096
1928	.2392	.2481	.2222	.2037	.2137	.2320
1929	.2710	.2639	.2433	.2101	.2381	.2506
1930	.2740	.2688	.2525	.2058	.2370	.2571
1931	.2833	.2755	.2488	.1905	.2445	.2577

1/ Where a limited number of companies are included within a district, separate data are not published.

Table 5. - Seasonal variation of gasoline consumption 1/

CITY BUSES

	United States		New England		Middle Atlantic		North Central		California-South Central		
Month	1924-31	1929-31	1924-31	1929-31	1924-31	1929-31	1924-31	1929-31	1924-31	1929-31	Month
Jan.	102.2	102.7	106.2	102.4	98.4	98.8	102.1	104.6	101.4	102.6	Jan.
Feb.	100.8	101.5	107.0	103.1	98.9	99.9	102.5	105.4	103.2	103.0	Feb.
Mar.	101.2	102.6	105.1	101.2	100.3	99.7	102.0	102.4	102.2	101.0	Mar.
Apr.	101.9	103.5	101.2	103.4	103.2	102.9	102.5	101.6	102.4	100.5	Apr.
May	101.4	102.4	97.6	99.8	103.7	104.2	100.5	101.2	100.5	98.7	May
June	102.3	102.2	97.2	99.7	103.6	103.8	101.5	100.1	100.7	99.5	June
July	99.9	97.5	93.0	94.5	100.1	99.3	99.1	95.9	96.7	97.4	July
Aug.	97.6	95.1	93.2	95.7	97.4	97.8	97.6	94.2	96.8	96.1	Aug.
Sept.	97.3	95.8	95.5	96.6	98.7	97.8	96.7	94.3	97.7	99.7	Sept.
Oct.	98.9	98.9	99.2	100.7	100.5	100.0	97.5	98.6	99.6	102.1	Oct.
Nov.	97.7	97.3	99.6	99.9	97.7	97.5	97.5	99.1	98.3	99.2	Nov.
Dec.	98.8	100.5	105.2	103.0	97.5	98.3	100.5	102.6	100.5	100.2	Dec.

1/ 100 = average monthly consumption.

Table 6. - Intercity bus data 1/

AVERAGE MILES TRAVELED PER BUS

Year	New England	Middle Atlantic	North Central	South Central	South Atlantic	Pacific Coast	Total United States
1924	-	-	-	-	-	52,434	48,150
1925	-	-	-	-	-	49,648	46,507
1926	37,271	-	-	-	-	47,885	44,942
1927	36,619	-	-	-	-	36,903	40,782
1928	37,462	32,870	65,738	-	-	35,647	40,561
1929	37,654	43,312	61,147	52,747	-	38,379	47,375
1930	37,516	44,289	63,682	63,512	-	42,847	52,826
1931	39,280	-	59,523	67,695	57,511	44,909	53,563

GALLONS OF GASOLINE CONSUMED PER BUS

Year	New England	Middle Atlantic	North Central	South Central	South Atlantic	Pacific Coast	Total United States
1924	-	-	-	-	-	6,140	6,061
1925	-	-	-	-	-	6,185	6,578
1926	6,997	-	-	-	-	6,547	7,551
1927	7,112	-	-	-	-	5,437	7,044
1928	7,203	6,379	12,864	-	-	5,782	7,247
1929	7,518	9,486	13,767	10,328	-	6,605	9,708
1930	7,408	10,012	14,836	12,825	-	8,359	11,201
1931	8,306	-	14,108	13,541	10,419	9,132	11,585

MILES TRAVELED PER GALLON OF GASOLINE

Year	New England	Middle Atlantic	North Central	South Central	South Atlantic	Pacific Coast	Total United States
1924	-	-	-	-	-	8.54	7.94
1925	-	-	-	-	-	8.03	7.07
1926	5.33	-	-	-	-	7.31	5.95
1927	5.15	-	-	-	-	6.79	5.79
1928	5.20	5.15	5.11	-	-	6.17	5.60
1929	5.01	4.57	4.44	5.11	-	5.81	4.88
1930	5.06	4.42	4.29	4.95	-	5.13	4.72
1931	4.73	-	4.22	5.00	5.52	4.92	4.62

GALLONS OF GASOLINE USED PER BUS-MILE

Year	New England	Middle Atlantic	North Central	South Central	South Atlantic	Pacific Coast	Total United States
1924	-	-	-	-	-	0.1170	0.1259
1925	-	-	-	-	-	.1245	.1414
1926	0.1876	-	-	-	-	.1368	.1681
1927	.1942	-	-	-	-	.1472	.1900
1928	.1923	0.1942	0.1956	-	-	.1621	.1785
1929	.1996	.2188	.2252	0.1956	-	.1721	.2049
1930	.1976	.2262	.2331	.2020	-	.1949	.2118
1931	.2114	-	.2370	.2000	0.1811	.2032	.2164

1/ Where a limited number of companies are included within a district, separate data are not published.

Table 7. - Seasonal variation of gasoline consumption 1/

CITY BUSES

Month	United States	New England	Middle Atlantic	North Central	California - South Central
January	102.7	102.4	98.8	104.6	102.6
February	101.5	103.1	99.9	105.4	103.0
March	102.6	101.2	99.7	102.4	101.0
April	103.5	103.4	102.9	101.6	100.5
May	103.4	99.8	104.2	101.2	98.7
June	102.2	99.7	105.8	100.1	99.5
July	97.5	94.5	99.3	95.9	97.4
August	95.1	95.7	97.8	94.2	96.1
September	95.8	96.6	97.8	94.3	99.7
October	98.9	100.7	100.0	98.6	102.1
November	97.3	99.9	97.5	99.1	99.2
December	100.5	103.0	98.3	102.6	100.2

INTERCITY BUSES

Month	United States	New England	Middle Atlantic-North Central	South Atlantic-South Central	Pacific Coast
January	97.5	101.5	96.3	97.2	95.1
February	98.2	102.7	93.1	101.4	93.2
March	95.6	99.7	91.6	96.3	91.2
April	97.2	99.9	89.9	101.0	96.3
May	101.6	98.4	94.2	104.4	104.9
June	106.5	99.3	110.1	105.0	109.1
July	108.9	101.7	115.3	99.7	109.7
August	111.0	98.4	118.9	101.2	108.3
September	102.2	99.7	105.4	97.7	102.7
October	96.5	97.8	95.6	99.7	99.0
November	93.1	98.6	94.0	99.9	96.7
December	91.7	102.3	95.6	96.5	93.8

1/ Based primarily on 1929-1931 gasoline consumption.

Table 8. - Gasoline consumed in the United States by revenue buses

(Thousand gallons)

Months	1928 City buses	1928 Intercity buses	1928 Total	1929 City buses	1929 Intercity buses	1929 Total
January	8,515.5	14,319.2	22,834.7	11,339.2	18,130.8	29,470.0
February	8,298.9	14,090.7	22,389.6	10,586.1	17,955.5	28,541.6
March	8,948.7	15,004.7	23,953.4	11,576.3	19,743.0	31,319.3
April	8,754.9	13,900.3	22,655.2	11,325.3	19,662.4	30,987.7
May	9,473.1	15,290.3	24,763.4	11,855.3	20,761.3	32,616.6
June	9,370.5	15,709.3	25,079.8	11,409.0	21,624.6	33,033.6
July	9,530.1	16,985.0	26,515.1	11,618.2	22,389.7	34,007.9
August	9,678.2	17,365.8	27,044.0	11,660.0	23,926.3	35,586.3
September	9,495.8	16,661.3	26,157.1	11,325.3	22,650.9	33,976.2
October	10,533.2	17,042.1	27,575.3	12,231.9	22,446.8	34,678.7
November	10,362.2	16,223.4	26,585.6	11,897.1	22,701.9	34,599.0
December	11,034.8	17,822.8	28,857.6	12,650.3	23,084.5	35,734.8
Total	113,995.9	190,414.9	304,410.8	139,474.0	255,077.7	394,551.7

Months	1930 City buses	1930 Intercity buses	1930 Total	1931 City buses	1931 Intercity buses	1931 Total
January	12,881.2	23,770.4	36,651.6	13,277.5	27,257.4	40,534.9
February	11,516.1	22,023.5	33,539.6	12,076.0	23,961.4	36,037.4
March	12,242.3	23,676.8	35,919.1	13,323.1	26,235.6	39,558.7
April	12,285.8	23,583.3	35,869.1	13,064.6	26,268.6	39,333.2
May	12,518.2	24,924.6	37,442.8	13,338.3	27,850.6	41,188.9
June	12,068.0	28,168.9	40,236.9	12,897.3	28,410.9	41,308.2
July	11,792.1	29,510.3	41,302.4	12,653.8	30,454.4	43,108.2
August	11,574.2	30,321.3	41,895.5	12,060.8	30,619.2	42,680.0
September	11,458.1	27,233.1	38,691.2	11,893.5	27,718.8	39,612.3
October	12,271.3	26,952.3	39,223.6	12,623.5	27,257.4	39,880.9
November	11,806.6	25,517.3	37,323.9	12,030.4	26,301.5	38,331.9
December	12,808.6	26,266.0	39,074.6	12,851.7	27,257.4	40,109.1
Total	145,222.5	311,947.8	457,170.3	152,090.5	329,593.2	481,683.7

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

THE MINERAL INDUSTRY (1)

By Scott Turner (2)

Within recent years, people have begun to realize the importance and significance of the mining and allied industries. The leading part the engineer plays in civilization is becoming recognized. However, accurate quantitative knowledge of the industrial importance of mining is still seldom possessed except by those close to this business. It is true that there are a few who go to the extreme and represent the whole progress of civilization as a reflection of man's gradual mastery of mineral utilization, but on the whole, the magnitude of the industry is underestimated.

The uncertainties of mining, as evidenced by the variable results of prospecting on surface or underground, in an unknown new field or from the bottom levels of a mature mine, the ins and outs of tonnages and metal contents, the possibility of a widespread or even a sudden change between cost and realization-price, add to its picturesqueness and make mining attractive to some. To many, the fact that results are generally more uncertain and less predictable than in other industries lends added charm.

The following pages may serve to call attention briefly to the importance of mining relative to other industries in the United States, in Canada, and in the world.

Ordinarily, the annual primary mineral production of the United States amounts to about 5½ billion dollars. The average for the last five years has been a little over 5½ billion dollars. Last year, sadly enough, it was less than 3¼ billions. Just now, we are on the decline, and have been for the past two years. In Canada, the 5-year average was about 268 million dollars. Last year it was 227 million. Due in part to gold output (in 1930, for the first time, Canada's gold production exceeded that of the United States), the Canadian average is holding up better than ours. It has been estimated that the average world mineral production over the past five years has amounted to about 12 billion dollars, while in 1931 it was less than 8 billions.

The mineral industries are as indispensable for the conduct of modern society as are those of agriculture, but, in the United States at least, they receive far less recognition from the Government. With us, agriculture is fostered by a great department that is maintained by enormous appropriations, while the mineral industries get but little financial support. In the United States, in the calendar year 1930, the value of production by these two industries were as follows:

Agriculture (inclusive of forestry) 9.9 billion dollars; mining 4.8 billions; ratio 2 to 1. Direct appropriations by our Federal Government were 109 million dollars to agriculture and 2.8 million to mining, a ratio of 39 to 1. Obviously this is out of balance to the extent of 19 to 1 in favor of agriculture.

That is to say, a dollar is appropriated by the Congress of the United States for each $90.60 produced by agriculture, while a dollar is appropriated for each $1,711 produced by

1 - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6643."
Epitome of a lecture delivered by the Director of the United States Bureau of Mines before the Royal Canadian Institute at Toronto, Ontario, Canada, on April 16, 1932.

2 - Director, U. S. Bureau of Mines.

mining. This constitutes a bold defiance of realities made possible only by the relatively late development of mining in a world previously preempted by agriculture and trade. Why government now continues to accord 19 times as much support to one basic industry as to another, can only be explained by the knowledge of the political factors involved.

The latest available figures for Canada are about as follows: The primary annual production of agriculture amounts to 1.9 billions; of mining, less than 0.3 billion; ratio 6.9 to 1. Appropriations were $10,870,000 to agriculture and $921,000 to mining, a ratio of 11.8 to 1. The discrepancy in treatment of the two industries thus indicated is comparatively slight, as a dollar is appropriated by Canada for each $174 of agricultural production compared with a dollar for each $299 of mineral production, the ratio here being 1 to 1.7.

Minerals are mined, but after they are won from the earth their subsequent treatment involves vast and complex industries the conduct of which requires much more skill and thoughtful direction than agriculture, and the welfare of which is probably of greater importance to society as now constituted in our countries.

It has been estimated that when we in the United States are producing, say 6 billions annually (we have exceeded 6½ billions), the employment of 2 million workers provides indirect support to perhaps 10 million people. When the raw materials furnished by our mines have been refined, processed, and fabricated, their wholesale value is over 15 billion dollars, and during this second period another 2 million workers have been kept busy, thus supporting another 10 million people. The third stage is distribution to the ultimate consumer, and this trade amounts to about 20 billion dollars, perhaps supporting 5 million more people. Thus we account for the livelihood of 25 million of our people. It has been estimated that on raw minerals alone the industry pays direct taxes to the Government totaling five times those paid on all the other raw-material industries combined.

In the 40 years from 1886 to 1926, per capita mineral production in the United States increased from $7.87 to $53.34, or sevenfold, while that in Canada increased from $2.23 to $25.61, or elevenfold. In 1886, production per person in the United States was 3.5 times greater than that in Canada, but the discovery of gold in the Klondike increased the Canadian mineral output so rapidly that by 1901 per capita production was almost equal to that of the United States. Thereafter, per capita production increased less rapidly in Canada than in the United States, resulting in a ratio of about 1 to 2 in 1926. During the current depression, mineral production has declined much less in Canada than in the United States, so that in 1931 the per capita production again is only slightly in favor of the United States, as will be shown later.

Per capita production of minerals

Year	U. S. A.	Canada	Ratio Canada to U. S. A.
1881	$7.82	(1)	(1)
1886	7.87	$2.23	1:3.5
1891	9.34	3.93	1:2.4
1896	9.04	4.42	1:2.0
1901	14.86	12.25	1:1.2
1906	22.15	12.85	1:1.7
1911	20.54	14.32	1:1.4
1916	34.82	22.05	1:1.6
1921	38.25	19.48	1:2.0
1926	53.34	25.61	1:2.1
1931	25.05	21.93	1:1.1

1 - Not available.

It is a surprising fact that there exists no record of the value of the world's mineral output. To arrive at a reasonable figure, it was necessary to establish some method of estimation. This was accomplished by selecting 13 minerals for which world production data were available, including most of the principal metals, coal, petroleum, and some other non-metallics. Quantity-production of these minerals in the United States, Canada, and the world was tabulated for certain years, converted into figures representing value, and then totaled. These totals for the United States and Canada were then compared to their total mineral productions. The ratios obtained by this comparison were then applied to the value of the world production of the 13 selected minerals to obtain an estimate of the total world mineral output, which thus appears to be, for 1929, $14,500,000,000.

The following table compares the mineral production of the United States, Canada, and the world for 1886, the first year for which data are available, and for 1900, 1910, 1920, and 1929.

Rate of increase in the mineral production of the United States, Canada, and the world

Year	U. S. A.			Canada			World (1)		
		Increase			Increase			Increase	
	Value	1886 =1	1900 =1	Value	1886 =1	1900 =1	Value	1886 =1	1900 =1
1886	$ 456,185,000	1.0	0.4	$10,221,000	1.0	0.2	$1,500,000,000	1.0	0.4
1900	1,108,936,000	2.3	1.0	64,421,000	6.3	1.0	4,200,000,000	2.8	1.0
1910	1,987,844,000	4.2	1.8	106,824,000	10.5	1.7	5,700,000,000	3.8	1.4
1920	6,981,340,000	14.6	6.3	227,860,000	22.3	3.4	17,000,000,000	11.3	4.0
1929	5,887,300,000	12.3	5.3	307,146,000	30.0	4.8	14,500,000,000	9.7	3.5

1 - Fstimated.

We all should be interested in the question of mineral production per capita of total population, in the United States and Canada, and of relatively greater increase or decrease in these two countries.

In the United States, the value of mineral production was $5,887,300,000 in 1929, and $4,810,400,000 in 1930. Since the total population in April, 1930, was 122,775,000, the mineral production per capita was $47 in 1929 and $39 in 1930.

In Canada, mineral production was $307,146,000 in 1929, and $279,873,000 in 1930. Population in June, 1930, is estimated at 9,934,000, indicating a per capita production of $31 in 1929 and $28 in 1930.

In the 43 years from 1886 to 1929, the mineral production of the world increased nearly tenfold, that of the United States over twelvefold, and that of Canada thirtyfold. Yet, notwithstanding the large increase, Canada's output was equivalent to only 2 per cent of the world total and to 5 per cent of the United States total in 1929. The average increase per year as determined by contrasting 1886 with 1929 was as follows:

World	$302,000,000
United States	126,000,000
Canada	7,000,000

The growth of total mineral production in Canada (since 1900) closely parallels that of the United States. Comparing the average total yearly output from 1901 to 1905 with that from 1926 to 1930, it is found that Canadian production increased 4.2 times while that of the United States increased 4.0 times. Growth of the three main branches of mineral production, however, showed considerable variation. For the same two 5-year periods, metal production increased 3.7 times in Canada and only 2.2 times in the United States; fuels increased 5.6 times in the United States and only 4.3 times in Canada. Nonmetallics showed a higher rate of increase in Canada than in the United States, the ratios being 5.9 and 4.5, respectively.

Ratios for all 5-year periods from 1901 to 1930 are shown in the following table:

Rate of growth of production of fuels, metals, and nonmetallics in the United States and Canada by 5-year averages, 1901-1930, expressed in terms of average production from 1901 to 1905

Period	Total		Metals		Fuels		Nonmetallics	
	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada
1901-1905	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1906-1910	1.4	1.4	1.3	1.2	1.4	1.6	1.4	1.7
1911-1915	1.6	2.0	1.4	1.7	1.8	2.1	1.6	2.8
1916-1920	3.7	3.1	3.1	2.7	4.7	3.6	2.8	3.6
1921-1925	3.7	3.1	2.0	2.3	5.4	4.1	3.9	4.3
1926-1930	4.0	4.2	2.2	3.7	5.6	4.3	4.5	5.9

The importance of metals, fuels, and nonmetallics in the mineral production of the United States and Canada presents some interesting contrasts. From 1901 to 1930, the relative importance of metal production in the United States declined, while that of fuels and nonmetallics increased. The same transition has taken place in Canada, though it is much less pronounced. Comparing the 5-year periods 1901 to 1905 and 1926 to 1930, it is found that in the United States metals declined from 42 per cent of the total mineral production to 23 per cent, whereas in Canada the decline was from 56 to 48 per cent. During the same periods, fuels increased from 39 per cent to 55 per cent in the United States and from 26 per cent to 27 per cent in Canada. Nonmetallic production increased from 19 to 22 per cent in the United States, and from 18 to 25 per cent in Canada. In recent years, metal production in the United States, and fuel production in Canada, are of the same order of importance with respect to the total mineral output of the two countries; a similar relation exists between fuels in the United States and metals in Canada. Nonmetallics have about equal importance in the two countries.

These various relations are shown in tabular form below:

Relative importance of metals, fuels, and nonmetallics in the mineral production of the United States and Canada by 5-year averages, 1901-1930, in per cent

Period	Total		Metals		Fuels		Nonmetallics	
	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada
1901-1905	100	100	42	56	39	26	19	18
1906-1910	100	100	41	49	39	30	20	21
1911-1915	100	100	37	48	43	28	20	24
1916-1920	100	100	35	49	50	30	15	21
1921-1925	100	100	22	41	57	34	21	25
1926-1930	100	100	23	48	55	27	22	25

In the United States, the mineral industry does not constitute as big a business as manufacturing and agriculture combined, but it is about on a par with railroad transportation. The mineral industries include, in addition to mines and quarries, the mills, smelters, iron blast furnaces, coke ovens, petroleum refineries, oil and gas pipe lines, manufacturies of clay products, lime, and cement, and many other activities; the practice is not to include steel works and rolling mills, which are generally classed as fabricating industries.

We have noted that roughly 2 million men are employed at or in our mines, which is a little greater than the number occupied in railroad transportation; about 800,000 work underground. Our coal mines alone employ many more men than are used in any manufacturing industry. With us, it is estimated that about 1 man in 40 works in the mines, whereas in Great Britain it is stated that 1 man in 10 is employed underground.

While it is well known that the railroads depend upon the products of the mines for more than half their tonnage, it is not so generally understood that this figure indicates these products in their raw condition, as mined, and does not include the tonnage involved in reshipments for reworking at smelters, refineries, at the large nonmetallic fabricating plants, and at the beneficiating establishments of the mineral-fuel industries. The oil business alone gives the railroads a tremendous tonnage from its refineries; the increased use of oil pipe lines thus gives the railroads much concern.

The annual production of the mines, which, as we have seen, has averaged nearly 6 billions during the past five years, is large as compared to the capital-investment in this industry, which is said to be something over 12 billions; thus annual production is half of investment, whereas the railroads, for example, exclusive of electric lines, annually produce an amount equal to one-fourth their capital investment of approximately 24 billion dollars.

The growing importance of minerals to man is readily shown on time charts representing the world production of such basic commodities as the mineral fuels or pig iron, as compared to the total white population. During the past century, while the production of pig iron was multiplied by more than 100, and that of the mineral fuels by about 75, with other metals taking similar courses, the white population of the world only increased about threefold. The production of minerals during the century ending in 1914 increased quite regularly from 5 to 7 per cent per year.

Among the better-known metals, during the past century zinc production increased at the most rapid rate, - in fact more rapidly than iron; copper comes next, closely paralleled by lead; then silver; and while gold production fluctuated more on account of two rapid rate-increases (about 1850, and again 50 years later), it also shows a marked increase during this period.

It has been estimated that more fuel and more metals have been used during the last 25 years than during all the time that went before. This regular and colossal increase could not continue; it is already slowing, and many believe that from now on the growth will be at a diminishing rate, as sharply contrasted with an increasing rate since the end of the eighteenth century.

It should be a source of satisfaction to the engineer to note that while production and wages have increased, unit costs have steadily gone down, both actually and as considered in comparison with accepted figures of general price level. The improvements in mining and metallurgical practices responsible for this lowering of cost have come by gradual evolution rather than by sudden change; the good results have been achieved through the experience and inventive genius of many men, perhaps working in widely separated regions and not in direct collaboration, but all contributing to progress in the art of mining. The most important single factor here has been a steadily increasing output per man-shift, in which America has led easily. Improvement in transportation has been important, while improved technology and more abundant and flexible mechanical power have helped throughout.

Exploiting mineral deposits is peculiar in certain regards, since the deposits are exhaustible, are of rare occurrence when measured in terms of outcrop-area as compared to total earth area, and may suddenly be handicapped or superseded by new discoveries; moreover, the economic position of the contained metals is affected by the use of scrap metal and the existence of invisible stocks.

The first characteristic, exhaustibility, is nearly monopolized by mining, although destructive cutting of virgin timber, ruthless overattack of naturally-fine fishing grounds, and thoughtless exhaustion of newly-cultivated soil faintly resemble it. Other factors remaining constant, each ton of ore extracted leaves the mine with a smaller reserve, less gross value, and shorter life. Agriculture, forestry, fisheries, water power -- all these involve the idea of constant fertility, growth, and replenishment. The orebody as an asset wanes steadily during exploitation. Depletion of the capital represented by the mineral deposit must be reckoned in accounting; the profits derived from mining often appear greater than they actually are, due to ignorance on the part of the stockholder as to amortization of his investment; the salvage-value of equipment is usually small when the ore is gone.

Many mines follow similar cycles. Discovery is followed by exploration, then exploitation. Experience shows that the ores near the surface are apt to be relatively highest in grade. While the richer and more easily accessible ore is being mined, with new plant, equipment, and crew, tonnage-costs may be high. The tendency from now on is to increase production-rate, handle lower-grade ore, and yet reduce costs per ton and per unit of metal recovered. To many engineers this period is the best, since progress and growth are apparent, while ingenuity and speed are amply rewarded. Imperceptibly the ore becomes poorer; increasing depth, water, temperature, and rock-pressure begin to show in higher costs per unit of metal and later in costs per ton of ore; probably, long before the end of the mineral deposit has been reached, these factors result in unprofitable operation, which after a time, when accompanied by failure to find new orebodies extending from, adjacent to, or in the neighborhood of the old one, lead to final stoppage of work.

The modern tendency is for the operating company, during the prosperous period, and with full knowledge of the progress of depletion and exhaustion, to look for new fields of operation in the same, neighboring, or distant areas; if successful in this, the end of the old operation may overlap the beginning of the new, so that corporate continuity is maintained. But never does the miner secure the comfortable permanence of the agriculturist. For the same plot of rich land to yield consecutive annual crops for five thousand years is not unheard of, and this might stretch to fifty thousand years, or ten times fifty thousand. Some small gold-bearing alluvial deposits may be somewhat replenished seasonally or periodically, but not one vein or lode mine in a hundred has lasted for even 20 years before complete abandonment. In the West, our thousands of forsaken mines, ruined camps, and ghost towns bear mute testimony to this cycle.

The same way that mines are mortal, so, on a larger scale, are mining divisions, districts, and regions. Even great states, nations, countries, and continents exhibit this ever-changing nature, insofar as their mineral resources are concerned. Within the past century, the center of mineral production has shifted from the Eastern to the Western hemisphere, from Great Britain to the United States. The locus of principal production had probbly passed from Egypt to Cyprus, then Asia Minor, Gaul, and to Germany, before moving to Great Britain.

As for the metal copper, the production-center has shifted from Cyprus to Spain to Sweden to Great Britain to Chile to the United States. In the States, the center moved from Michigan to Montana to Arizona. The United States, for half a century the premier copper producer, in which position she will continue for a long time to come, is witnessing what may be the first evidence of the ultimate surrender of her position, as indicated by the petition

of certain operators for a tariff on copper. For a generation, American copper mines have met all competition boldly, asking no favors of anyone, and dominating the world without artificial aid or protection. Central Africa, which produced copper in very early times, and which may once have been the world's center of production, seems to be destined, in the distant future, again to occupy the premier position.

The same, to a lesser degree, may be said of petroleum. Rumania dominated the oil world for two years, from 1857. The center of production then passed to the United States, whence came more than 90 per cent of the world's supply. In 1898, Russia became the greatest producer, but was overtaken by America in 1902; the major production has since remained with the States. The center of greatest production within the limits of the United States shifted from Pennsylvania to Ohio, then California, Oklahoma, back to California, then Oklahoma, then California, and so on until 1928, when the crown passed to Texas, where it has since remained.

The migration of production-centers is a fascinating study, and this constant shifting has its international, political, and military significances. As before suggested, new discoveries may tend to slow or quicken this movement, as may also beneficiation or the technology of treatment, and the important features involved in the problem of transportation, including waterways, trails, roads, railroads, airways, and pipe lines. Transportation problems differ from technologic problems relating to mining in that the former may be definitely and finally solved for the life of the mine, whereas the latter always remain variable and never reach a fixed or ultimate stage.

How small a part of the earth's crust is underlain by mineral deposits thus far discovered or worked, can be seen by the study of any map showing mining areas. Coal, oil, and gas are apt to be spread wide and thin, but many of the precious-metal deposits dip at steep angles and thus appear small when projected to a horizontal surface-plane. In the United States, the area underlain by known coal, bituminous and lignite, is only about 496,000 square miles, whereas our total area is 3,026,789 square miles. All the anthracite lies under 484 square miles of surface. Our proved oil area is only 7,037 square miles, or 0.2 per cent of our total. Thus if there were no overlaps in our oil and gas areas, the total for both would only be 13,194 square miles, or 0.4 per cent of our total. It is estimated that in the United States, 20.2 per cent of our entire area is geologically impossible for oil and gas, 44.9 per cent is unfavorable, 34.5 per cent may have prospective possibilities, while as noted before, only 0.4 per cent of the total area of the United States is underlain with proved oil and gas. In Texas, at the beginning of 1929, only 0.2 per cent of the surface was known to be underlain with oil, and in California, 0.1 per cent.

Some metallic ores occur in extreme geographic concentration. One small area in Canada produces nearly 90 per cent of the nickel of the world. One tiny tract in Belgian Africa supplies all our radium. No commercial deposits of tin, nickel, cobalt, radium, antimony, or platinum, and practically none of chromium or asbestos are found in the United States. How important internationally and strategically is this fact of intense and irregular localization, can well be realized if we consider what nations are without coal or oil, and glance over the list of so-called strategic minerals, of military importance, and note their narrow geographic and national distribution.

While we are familiar with corporate monopolies, or near-monopolies, in the case of such mineral commodities as radium, nickel, sulphur, diamonds, vanadium, and aluminum, we must also realize that some of these, and others such as helium, constitute national monopolies (in which class potash salts and nitrate used to be included), and their possession makes possible commercial or preferential treaties or secret understandings, which might lead to diplomatic agreements of grave international import. Leith has frequently emphasized the presence of known major mineral deposits around the North Atlantic area, guaranteeing extended industrial supremacy to Europe and North America, and affording particular advantage to the Atlantic seaboard of these two continents.

Since for the past century we have been going through the heyday of mineral production, while the goose hung high and improved conditions for increased production at lower prices have been visible on every side, we have tended to lose sight of the fundamental concept already stressed in this paper, of exhaustibility of our minerals. Contributing to this blindness, have been the facts that the immediately-available supply has kept up so well, and that the prices of minerals have quite steadily decreased (except during war or strike periods), both in unit cost and also in terms of the general price level of all commodities.

European countries have not fared so well; in the greatest of all mining industries, coal mining, unfavorable factors began to assert themselves in the early 1880's, and output per man has steadily declined since that time. England is an old coal-mining country, originally with wonderful resources. Already she has passed her prime, production per man underground is decreasing, costs are mounting, and the situation is critical. Yet it is said that only 6 per cent of all her coal has thus far been mined! This example of commercial difficulty long before exhaustion is significant! England produces less coal per man underground to-day than she did in the early eighties. As to other resources, it is reported that her most extensive and important deposits of iron, lead, copper, and tin ores have already been mined. Leadership in these things, hers not much more than a century ago, seems to have been lost, perhaps never to return to her.

America's turn will come, although increasing productivity per man was still in evidence up to a year ago, particularly in copper, iron, and other mines, but not, for instance, in mercury mines. This, however, should not deceive the informed engineer. Neither should he be put off by the plea of substitution in event of exhaustion. During the war, the chemist came rapidly to the fore, and it became the popular idea that a synthetic substitute, as good as the original, could be found to replace every waning mineral product. The rapid draft on our known supplies must loom large in the mind of every alert engineer.

While exploitation permanently destroys orebodies, the metal won from them is not lost so rapidly. In its new guise, it may continue to exist and be useful for long periods, in contrast to the products of agriculture, forestry, and most other primary industries. The result is a gradual accumulation of stocks, in more or less readily available and usable condition, particularly marked in the precious or semiprecious metals, which eventually becomes a factor in world supply. Although vast quantities of gold exist in other than monetary forms, in 1930 more than half of all the gold produced in the last ten centuries was actually in the form of monetary stocks that were valued at $11,522,579,000. Such an amount of gold, by the bye, would make a cube only about 31 feet on an edge. The annual production of $400,000,000 of new gold is thus less than 4 per cent of the total stocks. The more valuable and highly prized the metal is, and the less susceptible to oxidation or chemical change, the longer it lasts, although there are huge accumulations even of as common and chemically unstable a metal as iron, and the annual production of new iron constitutes a small fraction of the total. From the repeated manufacture and use of the stocked metals comes scrap, and this often constitutes an important source, and helps to postpone the exhaustion of supply of virgin metal.

Now let us briefly review the mining situation in Canada. We are all familiar with the discoveries of gold at Porcupine in 1909, Kirkland Lake in 1912, and Rouyn in 1924, and the consequent rise in gold production until Canada is now second only to South Africa as a gold-producing nation. The new finds at the Premier in 1910, Flin Flon in 1915, Sherrett's Cold Lake property in 1923, and the deep-seated ore at the Frood mine in 1925, have been encouraging episodes. Since 1920, the Sullivan mine has become the outstanding lead-zinc producer of the world. Other promising properties are coming along, and the public interest is intrigued by such names as Great Bear Lake, Copper Mines River, Pascalis, and others.

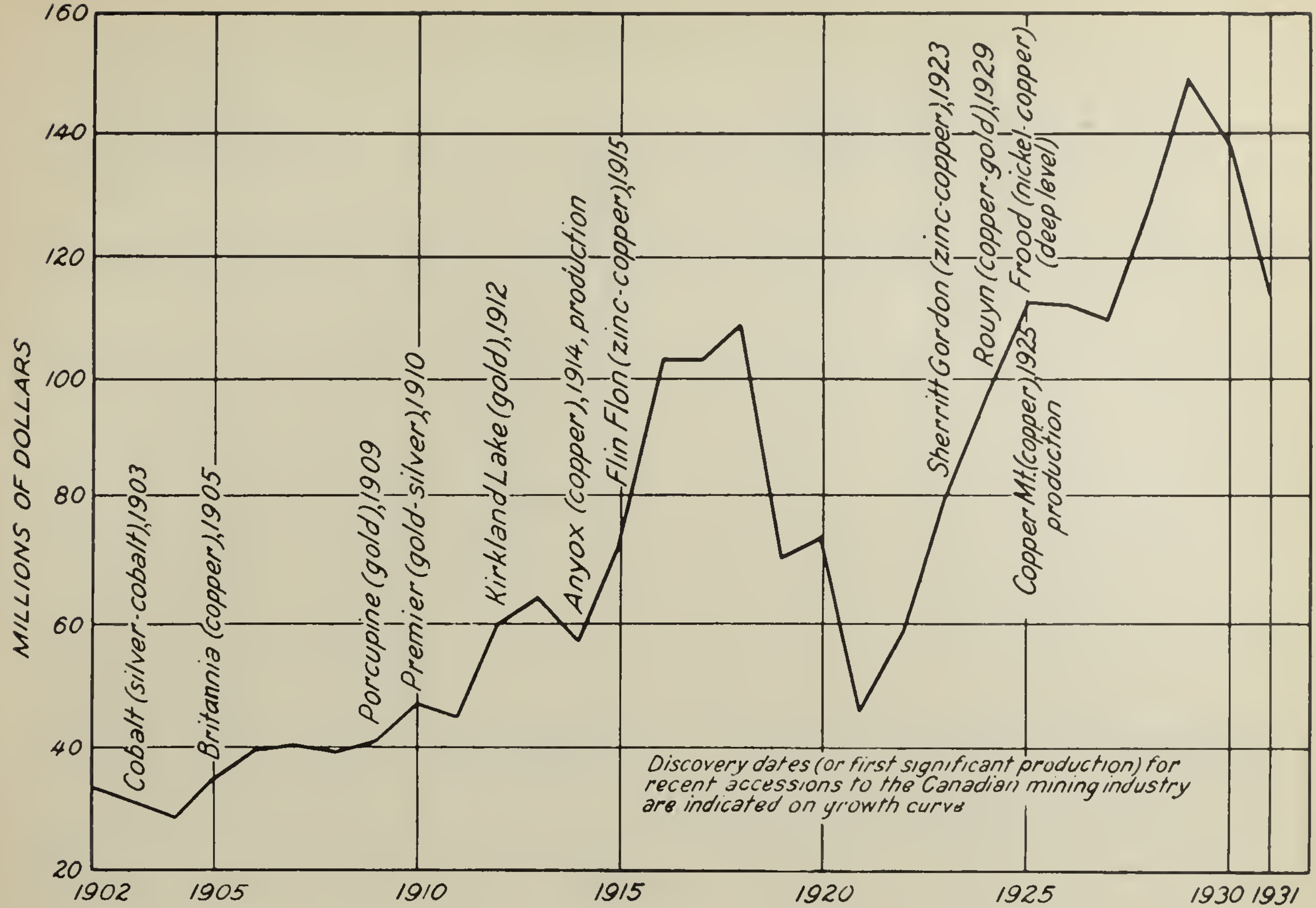

Figure 1.- Composite growth in production of gold, silver, copper, lead, zinc, and nickel (value) for Canada, 1902 - 1931

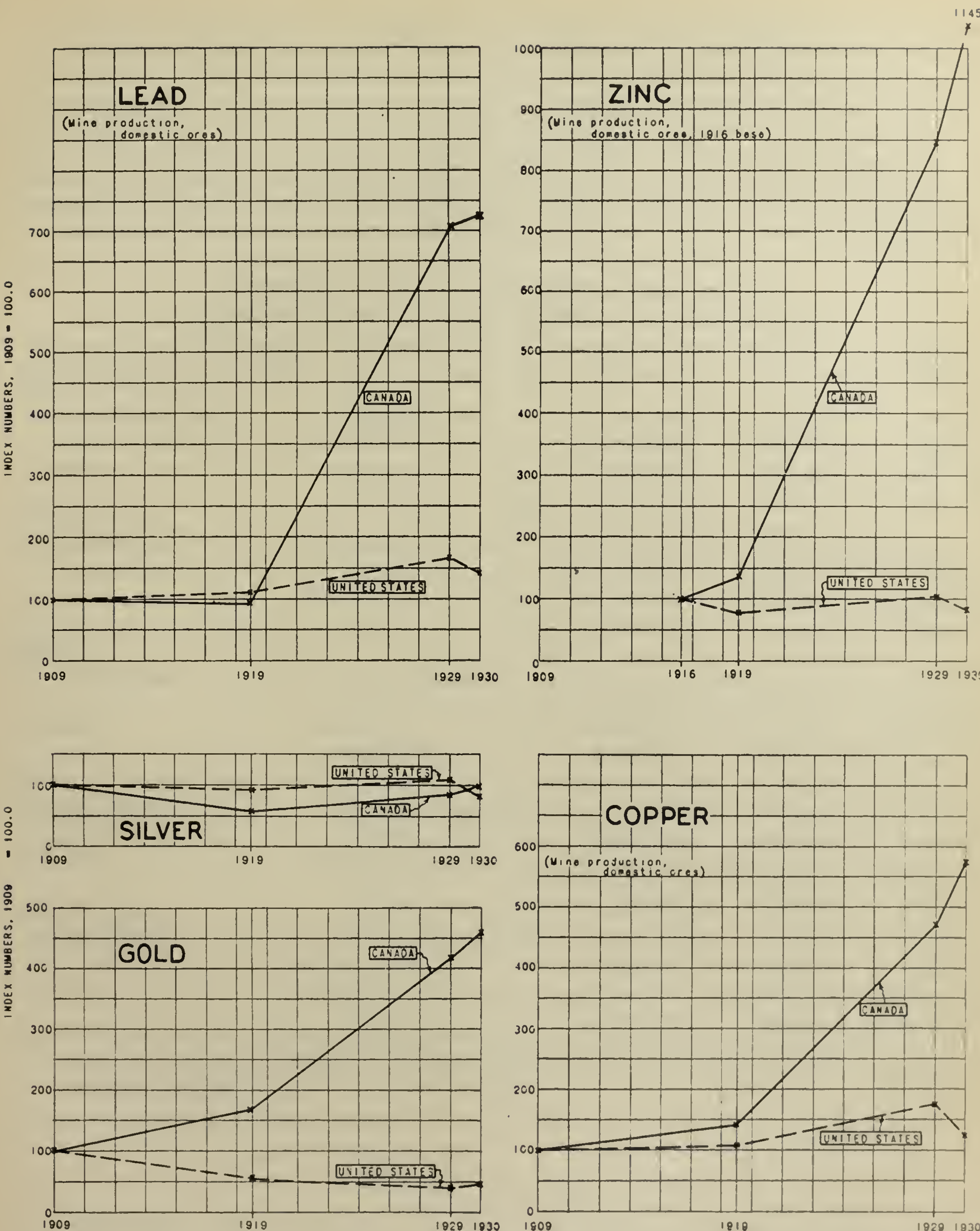

Figure 2.- Relative growth of metal production in Canada and the United States, 1909 to 1930

American engineers realize generally that Canadian mineral production is growing (see fig. 1), but only those who have had occasion to examine the figures appreciate the rapidity of this growth. American tonnages are the product of a population of 123 million people, and in comparing the two countries it is essential to take into account the smaller population of the Dominion. Another good way to do that is to compare, not the actual quantities, but rather index numbers representing the output of each country. This is done in Figure 2. For example, if we indicate the American production of lead in 1909 by the number 100, then the American production in 1919 is represented by the number 110 and in 1929 by the number 166. In other words, the American lead output shows an increase of 66 per cent in the 20 years.

Production of gold, silver, copper, lead, and zinc (recoverable mine output) for Canada and the United States

	1909	1919	1929	1930
Gold:				
United States (1)	4,798,342 ounces	2,753,282	2,219,613	2,138,723
	(100.0)	(57.4)	(42.9)	(44.6)
Canada	453,865	766,764	2,058,993	2,102,068
	(100.0)	(168.9)	(424.9)	(463.1)
Silver:				
United States	57,312,677 ounces	51,899,460	60,860,011	47,724,903
	(100.0)	(90.6)	(106.2)	(83.3)
Canada	27,529,473	16,020,657	23,143,261	26,443,823
	(100.0)	(58.2)	(84.1)	(96.1)
Copper:				
United States	1,126,521,126 pounds	1,212,334,041	1,995,110,398	1,410,147,374
	(100.0)	(107.6)	(177.1)	(125.2)
Canada	52,493,863	75,053,581	248,120,760	303,478,356
	(100.0)	(143.0)	(472.7)	(578.1)
Lead:				
United States	398,036 short tons	429,589	647,995	558,951
	(100.0)	(107.9)	(162.8)	(140.4)
Canada	45,857,424 pounds	43,827,699	326,522,566	332,894,163
	(100.0)	(95.6)	(712.0)	(725.9)
Zinc:				
United States	703,169 short tons	548,847	724,478	595,445
	(100.0)(1916)	(78.1)	(103.0)	(84.7)
Canada	23,364,760 pounds	32,194,707	197,267,087	267,643,505
	(100.0)	(137.8)	(844.3)	(1145.5)

Note: Figures in parentheses are index numbers base = 100.0 for 1909, except for zinc base = 100.0 for 1916.

1 - Not including Philippine Islands.

The Canadian output has grown much faster. From index 100 in 1909, it has climbed to index 712 in 1929. In other words, though Canada still mines less lead than the United States, its production has increased 612 per cent during a time when that of the United States increased 66 per cent.

Much the same condition is shown for zinc, copper, and gold. Only in silver does the growth-trend of the United States parallel that of Canada.

For 1930, production of the nonferrous metals fell off in the States, but in Canada lead held its own in spite of the depression, and zinc and copper rose to new heights. This behavior of Canadian output under the difficult conditions of the depression is due to complex economic reasons.

We have seen that this rapid expansion has brought Canada's per capita mineral production to high levels. As before stated, counting all minerals, the United States' production per capita is still higher; but considering only the precious and the nonferrous metals, Canada now outranks the United States. Grouping together all metals except pig iron and aluminum for Canada, and pig iron for the United States, we find that in 1929 the Canadian output was \$15.50 for every man, woman, and child in the Dominion, as against \$7.66 in the United States.

The comparison for the individual metals is shown graphically in Figure 3.

Comparison of per capita mineral production of Canada and the United States

	Canada	United States
Gold..............value	\$4.39	\$0.38
Copper..........pounds	30.5	11.41
Lead............... do.	33.4	9.3
Zinc................ do.	26.8	7.9
Silver........... do.	2.67	.41

The foregoing tabulation shows that in 1929 Canada produced \$4.39 in gold per capita of population, while the United States produced only \$0.38. In the Dominion, copper production was nearly 3 times, lead not quite 4 times, zinc almost 4 times, and silver over 6 times the corresponding per capita production in the States. On the other hand, production figures of pig iron, coal, oil, and gas show a large margin for the United States as compared to the Dominion.

So far, we have been considering various minerals; it should be noted that, in the world as a whole, the largest and most valuable of the mineral deposits are not the metals, but rather the fuels. The world picture is shown in Figure 4, in which the figures shown for value of world production of all minerals were calculated as follows: World production figures in terms of quantity were obtained for 36 of the principal minerals. Each of these was multiplied by the average value f.o.b. mine or smelter in the United States, except for coal, the foreign production of which was assigned a value 50 per cent greater than the average value f.o.b. mine in the United States. There remained a group of minerals, including clay, lime, sand, gravel, and stone, for which no satisfactory figures of world production could be developed. The production of these, however, was known for the United States, and the production for the rest of the world was estimated by assuming that it bore the same ratio to coal production as in the United States.

The results obtained by this method based on 36 minerals differ slightly from those based on 13 minerals used in the table of historical comparisons on page 3.

In 1929, the total value of the world's production of all minerals has been variously estimated at 13¼ to 14½ billion dollars. This figure represents the value at the mine or smelter. If one were to consider the additional value conferred by refining and processing petroleum and coal, or by fabricating the raw material into manufactured goods, the figure would, of course, be far larger. Of the grand total of 13¼ billions measured in this way,

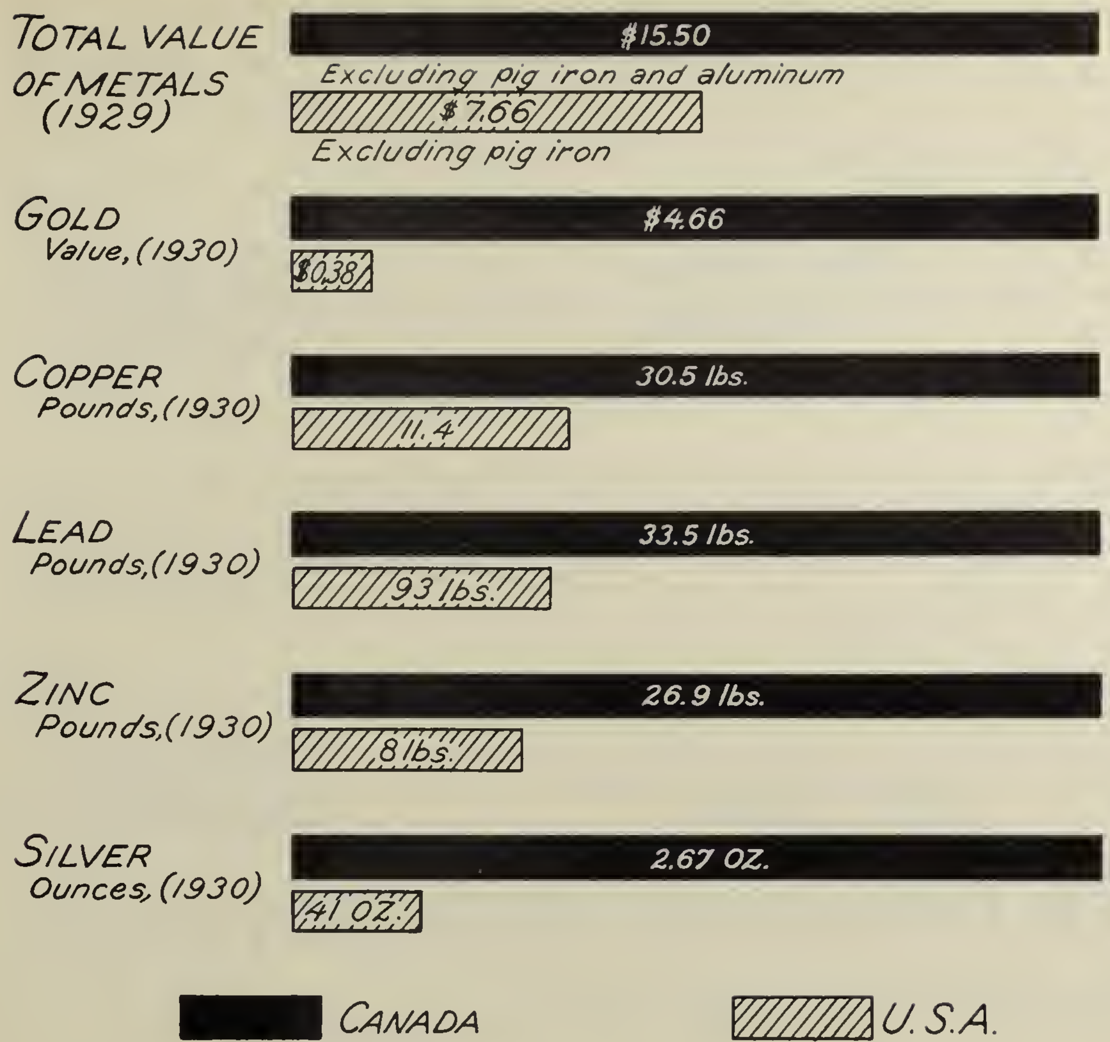

Figure 3.- Per capita production of metallic products in Canada and the United States, 1930

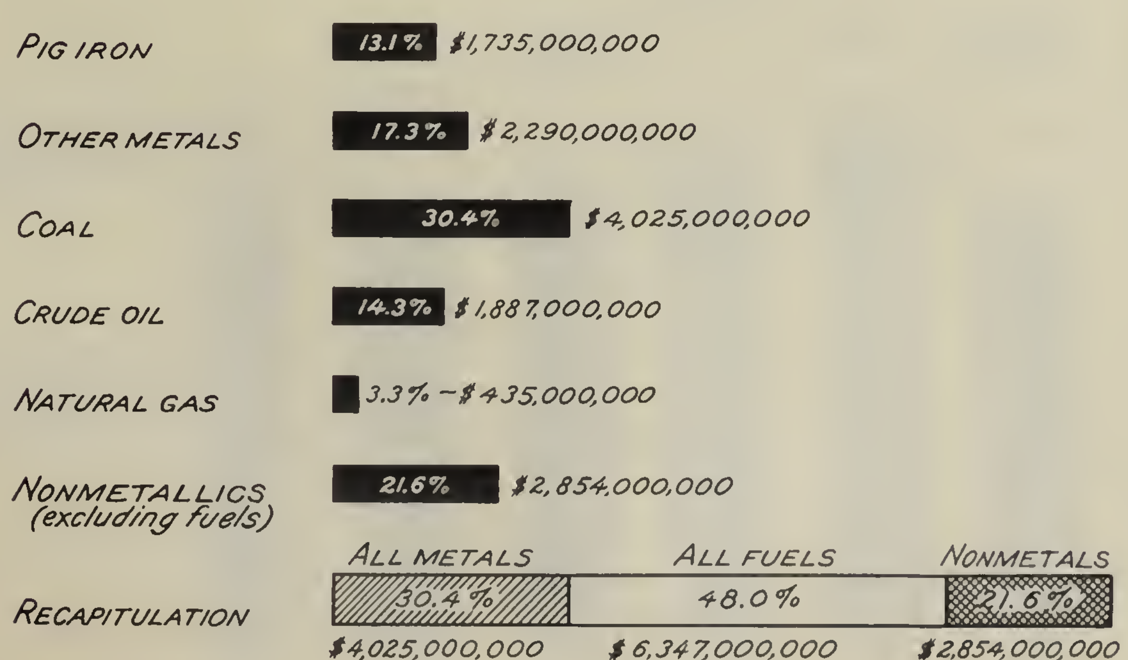

Figure 4.- Comparative values of world production of metals, fuels, and other nonmetals

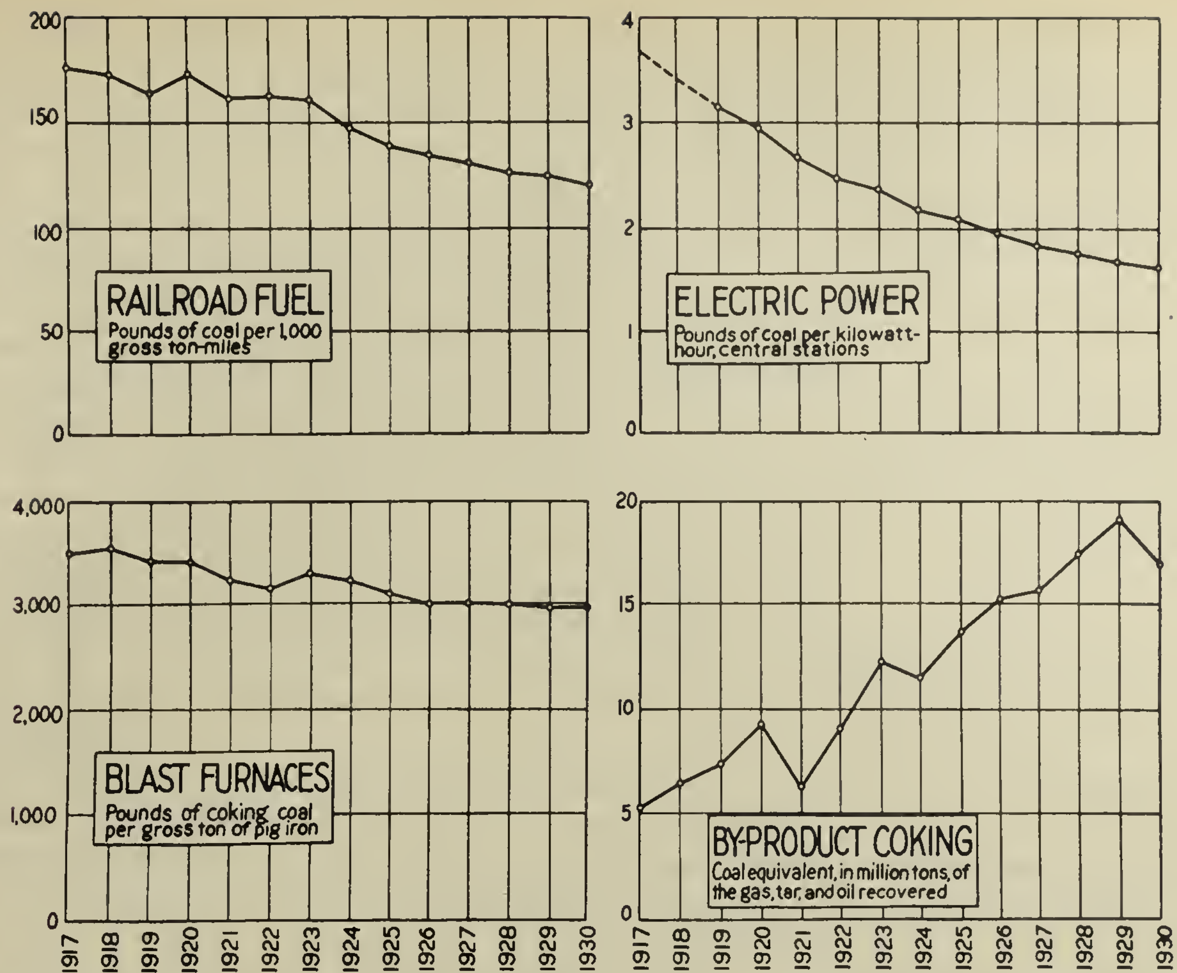

Figure 5.- Increased efficiency of coal utilization and production of coal equivalents, 1917 - 1930

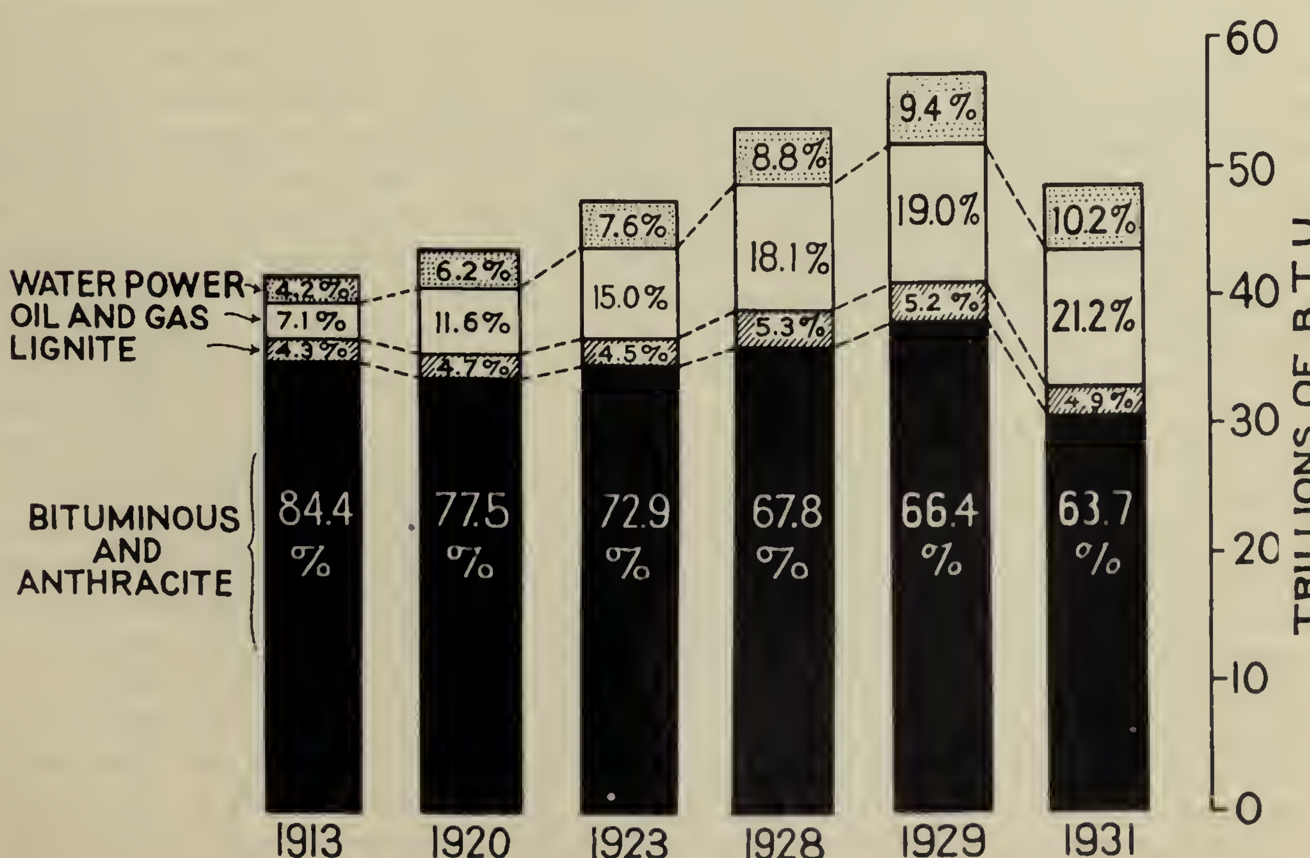

Figure 6.- Trend of the world's consumption of energy, 1913 to 1931

the mineral fuels contributed 48 per cent, the metals 30.4 per cent, and the nonmetallics 21.6 per cent. Pig iron contributed 13.1 per cent, as compared with 17.3 per cent for all other metals. Coal, with 34.4 per cent, exceeded by far the value of any other mineral. The value of the production of the anthracite mines of Pennsylvania alone is usually greater than, but is now practically equal to, the value of the gold production of the entire world.

To complete the picture we may note that crude oil and natural gas contributed 14.3 per cent and 3.3 per cent to the total, respectively.

In view of the great importance of the fuels, it is in order to sketch some of the outstanding tendencies in the world position of these commodities.

On the technical side, the record of the coal industry in recent years is one of brilliant achievement. On both sides of the Atlantic, a revolution in underground methods is under way. In the United States, and in Canada, too, this development centers around the mechanization of loading; parallel advances have been made in other underground operations and on the surface. The net effect of these changes is seen in the output per man per day, which has jumped from 3.61 in 1913 to 5.03 tons in 1930.

In contrast to this record of technical achievement, the economic position of the coal industry is far from satisfactory. A so-called world fuel surplus exists, much like the agricultural surplus, about which so much has been said and to remedy which so little apparently can be done.

In the case of coal, the underlying causes are clear. High prices associated with the war encouraged opening new mines, and great expansion of productive capacity. The same causes that prompted the operator to increase his facilities, prompted the consumer to improve the efficiency of combustion. From being an academic discussion, fuel economy became an organized movement. The results are found in all countries. For the United States the outstanding tendencies are outlined in Figure 5. The largest savings were made by the electric central stations, whose coal consumption per kilowatt-hour fell from 3.7 pounds in 1917 to 1.62 pounds in 1930. Similar results were obtained in locomotives, in blast furnaces, and in fact wherever records of fuel performances are kept; the wasteful beehive coke-oven was displaced by the by-product oven.

Scarcely less important than efficiency in the use of fuel, is the shift in the sources of the world's energy-supply. Coal is meeting increased competition from other sources of power, such as petroleum, natural gas, and water power. The world's consumption of energy has continued to increase in spite of the progress of fuel-utilization efficiency. From 1913 to 1929, the total energy-demand increased nearly 40 per cent. The increase, however, has come chiefly from the competitors of coal. In 1913 bituminous coal and anthracite contributed 84.4 per cent of the world's energy-supply. (See fig. 6.) In 1929 their proportionate share had dropped to 66.4 per cent. Meanwhile, the relative proportion of oil and gas had enormously expanded, and in 1929 roughly 19 per cent of the world's energy-demand was met from this source.

Water power, also, has shown great increase, particularly in Canada, but it remains a relatively small element in the world total. Viewing the world as a whole, something like 9 per cent to 10 per cent of the total energy-demand is now met by hydro-power.

Due to these economic conditions, the coal industry has undergone a long and painful retrenchment. Since 1923, more than 3,000 bituminous mines (commercial mines, not wagon mines) have been forced to close, and 250,000 men have lost their jobs. On the operator's side, the change has brought heavy financial loss. In most cases nothing was left for profits, as is shown by the corporation tax returns. In 1929, out of 2,300 American bituminous companies, only 900 made a profit. The remaining 1,400 companies operated at a loss, and the industry as a whole sustained a net loss of $11,000,000 for the year. Remember that 1929 was a year of heavy production, the sixth largest in the history of the business. Since 1929, of course, conditions have grown still more difficult.

Canadians perhaps think we are overcharging them for export coal. The plain fact is that consumers on both sides of the boundary have been getting their coal for less than they might reasonably be asked to pay. Aside from the question of tariffs, American coal is more accessible to consumers in the industrial sections of Ontario than it is to many consumers in the States.

The situation in oil is much the same. Overproduction and falling prices characterize the present position of the industry. While some results have been obtained from the efforts to control production, the market has been glutted and prices have been unreasonably low over much of the post-war period.

More recently we have witnessed a world tendency to overproduction in the metals. Although agreements to stabilize the market have been discussed, capacity to produce the base metals seems to have been growing faster than the demand. The problem of adjusting world supply to obvious limitations of world demand concerns all mineral producers. We have witnessed the tragedy of the agricultural surplus, the excesses in coal and petroleum. It seems pertinent to suggest that the warning signals be heeded with respect to the metals.

In this connection, careful thought must be given to the problem I have already mentioned: the steady accumulation of stocks of metals above ground and the increasing supplies of scrap material which return to plague the mining industry. Likewise, the tendency to expand capacity, unmindful of the influence of an excess of only 5 or 10 per cent upon the price structure for the whole industry, should be deferred until such time as consumptive needs are fully proved. Canadian and American mining companies have much the same interests, and will profit by joining hands to promote them.

We have been dealing largely with production-figures showing how Canada and the United States stand competitively. Let us now note how they supplement each other. Taken together, the two countries make a remarkably self-sufficient combination as far as minerals are concerned. In sheer volume, they dominate the world supply. Of the total value of mineral products for the world as a whole, the two countries contribute just about half -- in 1929, 47.1 per cent, to be exact. This percentage is based on an estimated total value of world mineral production of 13¼ billion dollars, as developed in Figure 4 and explained previously. In addition, the variety of their minerals is more complete than that of any other continent.

Since both countries are large producers, it might be supposed that they would also be fierce competitors. The element of competition is present, but it is important to realize that the mineral relations of the two countries are much more complementary than they are competitive. This complementary relation is brought out clearly in Figure 7.

Each country is an important producer of the metals, especially of copper, lead, zinc, gold, and silver, but each relies heavily upon the other for indispensable materials. First among Canada's unique contributions to the combination are its nickel and high-grade asbestos, virtually the world's supply of each, and its cheap, abundant, and convenient hydroelectric energy. The latter is already the basis of a rapidly developing electrometallurgical industry, and promises to play a role second only to that of her metallic resources in the development of a great mining and metallurgical empire.

On the other hand, the United States contains great reservoirs of oil and gas of which thus far Canada has insufficient supplies, and also deposits of high-grade coal so situated as to be the natural source of supply for Central Canada. In fact, American coal is said to be available to many Canadians at prices lower than those paid by many citizens of the United States. In iron and steel, also, the States are in position to supply Canadian industries cheaply and well.

Notwithstanding the generous share of the world's resources which the two countries enjoy, there are other minerals for which they depend upon outside sources. Conspicuous among these have been potash, nitrates, and platinum. In each of the three, however, recent

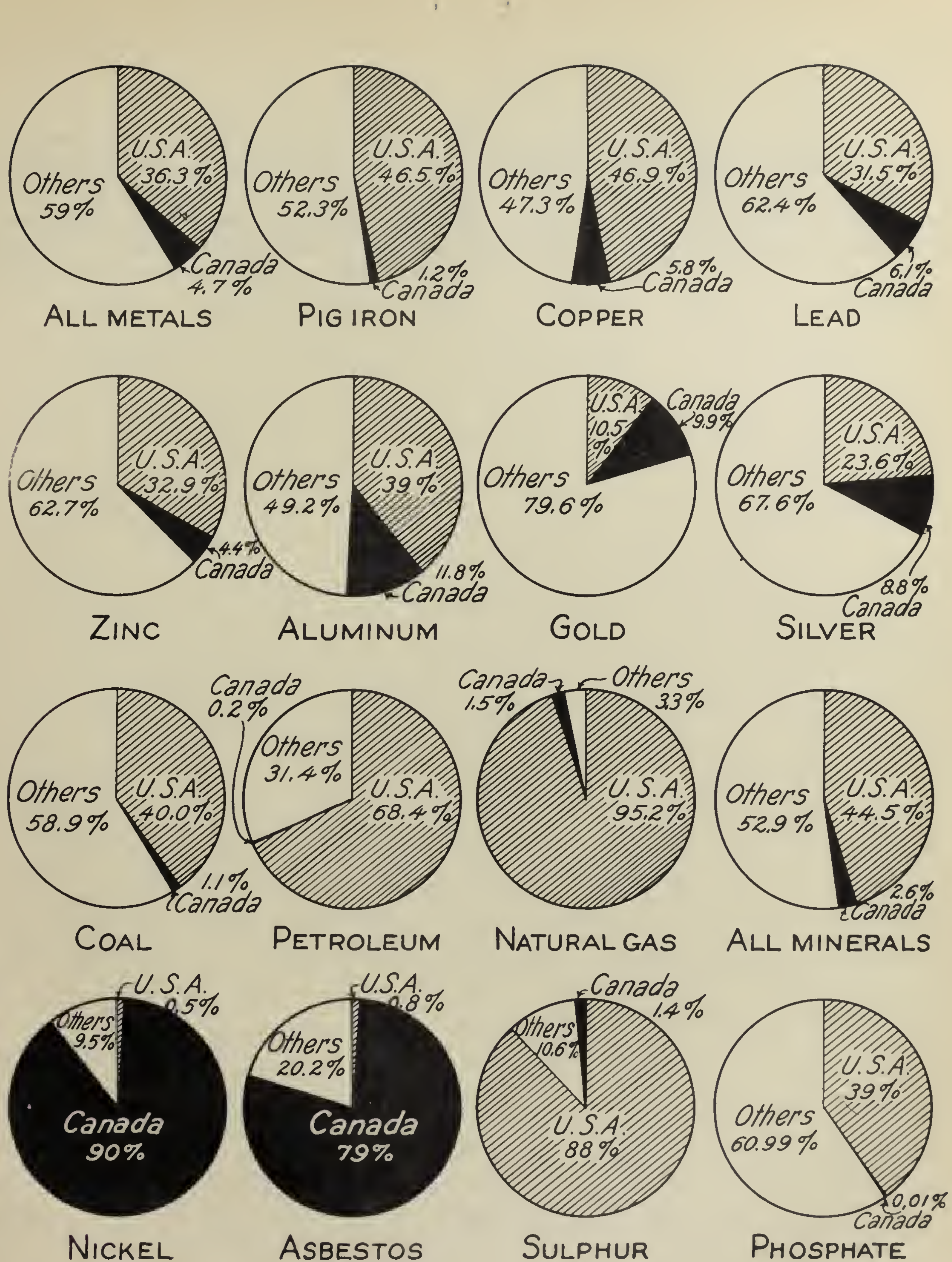

Figure 7.- Percentage of the world's mineral production contributed by Canada and the United States

developments promise supplies that may go far in meeting the needs of both countries -- platinum from Sudbury, potash from the American Southwest, and synthetic nitrates from fixation of atmospheric nitrogen. There remain a few minerals for which North America must still depend on the outside world, but who would care to say that the vast extent of the combined areas may not still contain some of the tin, manganese, and chromite needed to complete the mineral sufficiency of this continent?

I. C. 6644 March, 1933

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

MINING LAWS OF SIAM

BY

E. P. YOUNGMAN

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE--BUREAU OF MINES

MINING LAWS OF SIAM[1]

By E. P. Youngman[2]

PREFATORY NOTE

This paper is one of a series of digests of foreign mining legislation and court decisions that is being prepared in advance of a general report relative to the right of American citizens to explore for minerals and to own and operate mines in various foreign countries. In the preparation of this digest, access was had to official, though not legally binding, translations of the Siamese mining acts now in force, published by the Royal Department of Mines and Geology, at Bangkok. This circular is released subject to correction and amplification, if necessary, by the proper American foreign-service officers.

INTRODUCTION

The Siamese mining law, which is cited as "The Siam Mining Act, 2461 (1919)," was enacted February 14, B. E. 2461 (A. D. 1919), corresponding to the ninth year of His Majesty's reign. This act replaces the Siam Mining Act of 1901 and repeals all edicts, decrees, laws, rules, and local customs relating to mining the terms of which are inconsistent with the new law. It shall include all subsequent alterations or additions, as well as all rules issued by the Minister (of Land and Agriculture) already in force or to be brought into force -- publication in the Government Gazette to be deemed sufficient notice of any modifications or alterations. (Art. 1, 2, 5, 83, and 85.)

Legislation passed recently amending certain provisions of the mining law for the purpose of controlling the sale of minerals is the mining amendment act, B. E. 2474, given August 21, 1931 (7th year of the present reign), which repeals provisions of the mining act, B. E. 2461, and also all rules and regulations relating to mining that are inconsistent with the amending act. Under article 25 of the mining amendment act, B. E. 2474, ministerial regulations (of the Minister of Agriculture) were issued August 21, 1931.

Further recent legislation, brought about by the agreement of the Siamese Government to become a party to the international tin restriction scheme (international tin pool), is the tin and tin ore restriction act (Siam), B. E. 2474, which came into force on September 1, 1931, its purpose being to suspend the

1 The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6644."

2 Rare metals and nonmetals division.

operation of all laws, by-laws, or regulations dealing with mining or terms and conditions appearing in pratanabats, or special mining permits (concessions), that are inconsistent with the tin and tin ore act, as long as the act remains in force. (All the signatory governments to the international tin quota scheme agreed to remain in the pool for a period of three years from August 12, 1931, or until the proper liquidation of the pool.[3]) (See section of this paper entitled "Mineral Industry and Resources.") Ministerial regulations, issued by the Minister of Lands and Agriculture, under section 39 of the tin and tin ore restriction act, were passed August 21, 1931.

The official translations of these laws that were used in the writing of this circular were made by the Department of Mines to assist persons unacquainted with the Siamese language, but with the express condition that they should not have the legal force of the original Siamese text.

RIGHTS OF FOREIGNERS

The Siamese mining law itself makes no distinction between natives and foreigners.

The treaty[4] now in force between Siam and the United States contains the following provisions:

> The citizens or subjects of each of the high contracting parties shall have liberty to enter, travel, and reside in the territories of the other, to carry on trade ... to lease land for residential, commercial, religious, and charitable purposes ... and generally to do anything incident to or necessary for trade upon the same terms as native citizens or subjects, submitting themselves to the laws and regulations there established.
>
> They shall not be compelled under any pretext whatever to pay any internal charges or taxes other or higher than those that are or may be paid by native citizens or subjects. (Art. 1.)
>
> The dwellings, warehouses, manufactories, and shops and all other property of the citizens or subjects of each of the high contracting parties in the territories of the other and all premises appertaining thereto used for purposes of residence or commerce shall be respected. It shall not be allowable to proceed to make a domiciliary visit to or a search of any such buildings and premises or to examine or inspect books, papers, or accounts, except under the conditions and with the forms prescribed by the laws, ordinances, and regulations for nationals. (Art. 2.)

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3 The Bangkok Times, Jan. 23, 1932.

4 Treaty and Protocol Between the United States and Siam: Treaty Ser. No. 655, proclaimed October 21, 1921. This treaty was to come into effect on the date of the exchange of ratifications (Sept. 1, 1921) and was to remain in force for 10 years. However, in case neither of the contracting parties should have notified 12 months before the expiration of the 10-year period an intention to terminate it, it was to remain binding until the expiration of one year from the date on which either of the parties should have denounced it. (Art. 17.) No denouncement has taken place.

Limited-liability and other companies and associations, already or hereafter to be organized in accordance with the laws of either high contracting party and domiciled in the territories of such party, are authorized, in the territories of the other, to exercise their rights and appear in the courts either as plaintiffs or defendants, subject to the laws of such other party.

There shall be no conditions or requirements imposed upon American corporations, companies, or associations in connection with such access to the courts of justice in Siam, that do not apply to such native corporations, companies, or associations of the most favored nation. (Art. 5.)

It is understood by the high contracting parties that the stipulations contained in this treaty do not in any way affect, supersede, or modify any of the laws, ordinances, and regulations with regard to trade, naturalization, immigration, police, and public security that are in force or that may be enacted in either of the two countries. (Art. 15.)

GENERAL LEGISLATION

As all mineral lands are the property of the Crown, permission either to prospect or to mine must be obtained from the Government, through an ordinary prospecting license (ahtyabat), an exclusive prospecting license (ahtyabat pukart), a mineral washing license, or a mining agreement (pratanabat).

A person desiring to work for minerals on other than vacant[5] land shall, if he is the owner, produce a title deed (such as chanote or Kra Chong); if he is not the owner, he shall obtain a letter of authorization to accompany his application to work for minerals. (Art. 74.)

No person, except with special permission of the Department of Mines and under conditions imposed by it, shall prospect or mine within 20 wah[6] of a highway, waterway, or building or within 500 wah of any fort or naval or military station. (Art. 73.)

STATE OWNERSHIP

All lands and minerals, including oil and coal, within the Kingdom of Siam are Crown property. No one having the legal right to occupy land for building, agriculture, or any other purpose may prospect or mine upon that land without special governmental permission. (Art. 4.) Furthermore, the State reserves the right to resume any plots of land within a ceded mining area for any public purpose -- compensation to be made to the holder of the mining right for actual loss with respect to structures of any kind, but none for the value of the minerals upon the resumed land. (Art. 72.) The Government reserves the right to take from mining land for its own use any earth, stones, or sand found

5 Vacant land is that upon which there is no cultivation, no building, nor reservation, according to law, for either public or individual benefit. (Art. 3.)

6 One wah equals 80 inches.

thereon (art. 70) or to grant to any person permission to fell timber, burn charcoal, or collect gums and other forest produce within any mining area (art. 71). The Minister is authorized to acquire for mining purposes any land occupied for other purposes by issuing notice to the owner of the land and fixing the date for its surrender. (Art. 75.) A mining right does not convey the right of ownership in land. (Art. 51.)

MINING AUTHORITY

Mining authority, in general, is in the Royal Department of Mines (art. 2), which is known also as the "Department of Mines and Geology," under the Ministry of Lands and Agriculture.[7] Mining matters are directly administered through local branches either in the district[8] (amphur), province[9] (changwad, or circle[10] (monthon), if such offices exist, or through the head office at Bangkok. (Art. 3.)

The Ministry (of Lands and Agriculture) is empowered to make rules fixing royalties, rents, and fees; these rules shall be considered to be a part of the act upon their publication in the Government Gazette. (Art. 82.)

The decision of the Department of Mines shall be final in any boundary dispute. (Art. 80.)

The district mines office (or the rachalohakit in charge) shall have authority to recall a mining agreement or a plan in connection therewith for correction of clerical errors or for correction of boundary marks that do not correspond with those on the ground. (Art. 81.)

ORDINARY PROSPECTING LICENSES

An ordinary prospecting license (ahtyabat), which is not transferable, is a personal license, although it covers employees of the licensee. It gives no prospecting right beyond that of "testing the metalliferous qualities of the ground."

The license, for which application must be made in writing (on the form prescribed by the Government) to the district mining office, confers the right to prospect for one year for the mineral or minerals specified in the document and only on the vacant land within the limits specified -- the permission of the owner of the land being necessary with respect to other than vacant land. A license may extend over one province, at the discretion of the issuing official. (Art. 13, 14, 15, and 16.)

EXCLUSIVE PROSPECTING LICENSE

An exclusive prospecting license (ahtyabat pukart), which is not transferable, beyond excluding from prospecting any one other than the holder himself and his servants, confers the same rights as the ordinary permit. The area of

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7 Rogers, ________, ____________: Despatch 272, Siam, Sept. 16, 1930, State Dept. file F.892.631/1.

8, 9, 10 Siam is divided into 14 circles, subdivided into 79 provinces, subdivided into 413 districts, subdivided into 5,109 communes.

an ahtyabat pukart shall not exceed 3,000 rais (450 hectares). It is issued for 12 months but may be renewed for one-half of the area covered by the original license (or for a larger area with the consent of the Minister), if the licensee is able to show to the satisfaction of the Department of Mines that he has completed a reasonable amount of work and has otherwise complied with the conditions of his permit and the provisions of the law. (Art. 18 and 20.)

Application. - A written application shall be made either personally or through a duly authorized agent to the district mines office (or to any other branch office the Department of Mines may direct). The application shall be accompanied by (1) a description of the land applied for and (2) a plan giving accurate particulars of its boundaries and of its position with reference to a boundary mark of an existing mining area or to a "traverse station" or to some fixed physical point. The applicant may at any time previous to the issuance of the license withdraw his application upon paying a sum equal to one-half of the fees due for the license, together with all expenses, if any, incurred by the Government in cutting and surveying boundaries. (Art. 18 and 19.)

Survey. - After an application has been examined, the Government shall notify the applicant whether he or the Government shall undertake the cutting of the boundaries. The applicant shall pay the costs should the Government do the work; he shall complete it in the time prescribed should he do the work himself. (Art. 18 and 19.)

Cancellation. - The Minister may withdraw an exclusive prospecting permit at any time that the holder fails for a period of six consecutive months to carry on reasonable prospecting. (Art. 20.)

MINERAL WASHING LICENSES

A mineral washing license, which is not transferable, is issued only to one desiring personally to wash for minerals in certain previously authorized districts. The license, for which application is made to the district mines office, confers upon the holder the right for one year to wash for minerals in any vacant land in the district or districts specified in the license. (Art. 7, 8, and 11.)

MINING RIGHTS

A mining right (pratanabat), which must receive the sanction of the King and must be signed and sealed by the Minister, shall be valid for not more than 25 years. (Art. 29 and 31.) The possession of sufficient capital to work the land applied for may be required of the applicant. (Art. 21.)

Minerals covered. - Only such mineral or minerals as may be specified in the mining agreement shall be mined, treated and sold. Separate application must be made for the exploitation of any mineral found that is not included in the pratanabat. (Art. 51 and 69.)

Area. - A mining area shall not exceed (except with special permission of

the King) 100 rais (15 hectares) "on a lode"[11] or 300 rais (45 hectares) on alluvial[12] or iron-ore ground. When possible, the area shall be rectangular - the length not to be more than three times the breadth. (Art. 26 and 27.)

Application. - Application must be made in writing to the district mine office (or to any other branch office authorized by the Government). The application, which shall contain a description of the land, the name of the mineral to be mined, and the method of mining, shall be accompanied by a sum of money sufficient to cover all fees and expenses in connection with boundary lines and marks, by a plan of the area, and by all data necessary accurately to locate the land. (Art. 21.)

Survey and demarcation. - As in the case of the exclusive prospecting permit, when the application has been examined, the Government shall notify the applicant as to who shall undertake the survey. If the applicant is to do the work, he shall complete it to the satisfaction of the Department and shall lodge field notes and plan with the district mines office within a specified period of time (or authorized extension thereof). If the Government undertakes the survey, the applicant (in person or through an agent) shall be present to point out the boundaries of the land applied for, and he shall pay all expenses in connection therewith. After the demarcation has been completed, public notice shall be posted for a period of not less than 15 days in the district mines office or other suitable place, in order that objectors may file their protests in writing. If no objection is made, the land shall be surveyed, and the boundary marks shall be erected. (Art. 22-25.)

Temporary working permit. - If an applicant should wish to begin mining after the completion of the survey but before the issue of the mining right, he may apply to the district office for a temporary mining permit, which shall confer the same right as the pratanabat, except that it shall not be transferable, shall be in force for only six months, and shall be subject to cancellation without notice, without assigned reason, and with no right to compensation. (Art. 28.)

Work conditions. - The number of workmen to be employed on any mining area (or the equivalent labor-saving apparatus, at the rate of 1 brake horsepower to eight workmen) shall be stipulated in the mining agreement - the number of workmen not to be less than one to every 2 rais of land.

The work shall be carried on without an interruption of more than six months in any one year or 12 months in any two years, unless exemption shall have been granted. A district mining officer, if satisfied concerning the inability of the lessee (pratanabat holder) to work his mine, may grant a certificate of exemption for such a period not in excess of three years as he may see fit. (Art. 37 and 38.)

Surrender and forfeiture. - In order voluntarily to surrender a mining right, the holder thereof shall send a written notice of his intention to the district office, which shall make a determination within six months or within

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11, 12 Lode equals seam, deposit, vein, reef, dike, or blow containing minerals other than alluvial ground. Alluvial ground equals loose rock or stone, clay, sand, soil, or earth from which minerals may be obtained by washing. (Art. 3.)

a period mutually agreed upon. The holder of the mining right shall be liable for all sums due to the Government up to the date of the determination. (Art. 39.)

Forfeiture of a mining right may result from the holder's bankruptcy (art. 48), from failure to pay (within 90 days of the receipt of notice of indebtedness) all sums due to the Government (art. 76), or from failure to comply with the conditions of work (art. 37). Should a lessee commit any fault that renders him, under the law, liable to forfeiture of his right, the Department of Mines may (1) order the holder to make good the fault within a specified period or (2) notify him of the fault and of the cencellation of his right, in which case appeal may be made to the Minister. (Art. 40.) Publication of a determination in the Government Gazette shall be considered sufficient notice thereof. (Art. 41.)

Whether a right has been voluntarily surrendered or declared forfeit by the Government, all mined ore, all buildings, machinery, tools, and appliances, unless removed within six months (or within a longer period officially authorized), shall become the property of the State. (Art. 42.)

Transfer. - A mining right may be transferred if the document of transfer is signed and sealed by the Minister, with the sanction of the King. Should an application (to be made through the district office) for right of transfer be approved, the lessee and the prospective transferee shall present, in person or through an agent, all documents under which the right to mine was obtained. The deed of transfer shall be executed in triplicate, one copy for the head office, one for the district office, and one for the transferee. (Art. 45.)

Should a lessee die, determination of his pratanabat shall be made within 90 days of his death, except that a representative of the deceased lessee may make application within 90 days for the right to continue mining and may have the right assigned to him. (Art. 46.)

No pratanabat (either in whole or in part) shall be used in the liquidation of a debt or be attachable for debt. It shall not be subject to mortgage or charge of any kind that has not been sanctioned by the Department. (Art. 47.)

ROYALTIES AND RENTS

The ministry has power to make rules regarding royalties, rents, and fees and to direct where they shall be paid. Interest on overdue accounts shall be at the rate of 15 per cent per annum. (Art. 77 and 82.) The holder of a washing license shall pay royalty at the rates in force from time to time (art. 10); the holder of a mining right also shall pay royalty at the prevailing rate unless the rate is specifically set forth in the mining agreement (art. 33 and 34).

Annual rental shall be fixed in the mining agreement and shall be paid in advance in equal half-yearly instalments. (Art. 32.)

WATER RIGHTS

The inalienable right to control all water courses (or waterways[13]) is vested in the State, although provisions are made whereby the lessee of a mine may have the fullest use of water facilities. (Art. 59-63.)

13 Any river, stream, canal, pond, well, ditch, or body of water, running or still, natural or artificial. (Art. 3.)

EASEMENTS

Every mining area is subject to existing rights of way and other easements. (Art. 66.)

A lessee shall obtain the consent of the occupier of the land before constructing roads and ways in the mining area for the transportation of ore and other material and shall obtain the consent of the viceroy, lord lieutenant, or governor of the district concerned before constructing them beyond the mining area. (Art. 67 and 68.)

Every lessee may cut such timber within his mining area as may be necessary in his mining operations, subject to the forest laws and subject to the vested interests of others in such timber. He may obtain through the Department expropriation of such vested interests in case of disagreement. The amount of compensation, if disputed, shall be determined by arbitration. (Art. 50.)

Upon written permission from the district office, a lessee may use any vacant land in his mining area for the erection of buildings, the planting of vegetables, and the keeping of animals necessary to his operations. (Art. 51.)

FINES

In general, a fine not to exceed 500 ticals (Tcs. 500)[14] is imposed for any infringement of the mining law for which no specific penalty is stipulated. (Art. 79.) Specific fines, ranging from 1 tical a day to a maximum fine of 1,600 ticals, are covered by articles 4, 9, 12, 15, 17, 35, 37, 54, 55, 69, 73, and 81.

MISCELLANEOUS REGULATIONS

Every mine shall be under the control of a competent manager, whose name shall be recorded in the district mines office. (Art. 49.)

Should a rachalohakit monthon (representative of the Department in a circle) or a rachalohakit changwad (representative in a province or district) or a senior officer consider that mining operations do not, either below or above ground, safeguard life and property, he may order the necessary remedies or may order suspension of work until required changes shall have been made. (Art. 53 and 56.) Abandoned shafts or workings shall be securely fenced. (Art. 58.)

At the commencement of each month every mine holder shall report in detail the amount of metals and minerals produced, smelted, and exported during the preceding month, the number of working days, and the daily average of labor employed, and (if so required) furnish an accurate plan of works and excavations made below ground to date. (Art. 35.)

Every mine holder shall keep proper books of account with respect to mining costs and the details just enumerated and shall keep such accounts open to the inspection of duly authorized officials of the Department and shall furnish attested copies thereof when so ordered. (Art. 54.)

14 The exchange value of the tical in 1930 was 43 cents in U. S. currency.

The Department shall have authority to order a lessee to make a detailed plan of his mining area, to hold the plan open to inspection by Government officials, and to furnish an attested copy thereof upon demand. The detailed plan shall include the surface and such underground workings as the Department shall direct; it shall be on a scale of 1:2,000, or on such scale as may be required; and it shall be accurately brought to date at intervals of not more than one month. (Art. 55.)

Every lessee shall forward (at the date of publication) to the district office a copy of all published reports upon the mining area; a leasing company shall forward also a prospectus, a memorandum of association, and the articles of association. (Art. 36.)

No action at law (except with the sanction of the Minister) may be brought against an officer of the Department acting in good faith and in discharge of his duty. (Art. 85.)

A lessee upon finding objects of palaeontological or historical interest shall surrender them to the Department, together with a description of the conditions under which and the locality and the strata in which they were found. (Art. 57.)

The liability of employer and of employee in case of a breach of the mining law by a workman shall be governed by laws relating to master and servant. (Art. 78.)

Every holder of a prospecting or a mining right shall register a Siamese address with the district mines office. Any notice or letter sent by the Government to such a registered address shall be deemed to be legal service thereof. (Art. 43 and 84.)

Regulations made to prevent damage to the ground by tailings and to prevent the pollution of domestic water sources are contained in articles 64 and 65.

MINERAL-SALE CONTROL[15]

In general, the mining amendment act (B. E. 2474), controlling the sale of minerals, prohibits the purchase[16] or storage of any minerals whatever except under a purchase license or a storage license, which licenses expire on March 31 of the Siamese year in which issued. The pratanabat holder (concessionaire) is exempted from this provision in so far as it relates to storage, as follows:

> Provided that this prohibition shall not apply to the keeping of premises in any place for the purpose of storing therein minerals won from the area of a pratanabat, or special permit (concession), by the holder thereof. (Sec. 5.)

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15 The Mining Amendment Act, B. E. 2474; Ministerial Regulations under section 25 of the Mining Amendment Act, B. E. 2474.

16 Purchase means to purchase, exchange, receive by way of gift, or acquire from some other person. (Sec. 4.)

Likewise, no minerals shall be sold to other than the holder of a purchasing license or sublicense. (Sec. 16.)

Application for a purchase or a storage license is made, in the prescribed form, to the district mines officer. A fee must be paid for either license, and a deposit must be made with respect to a purchasing license, according to prevailing ministerial regulations. (Sec. 7.)

No minerals, other than minerals won by washing by the holder of a mineral washing license, shall be removed from within the boundaries of the land from which minerals have been raised or from one place of business for purchasing minerals to another unless accompanied while in transit by a transit note in the prescribed form, containing the following main particulars: (a) The name of the owner of the minerals; (b) the weight of the minerals; and (c) the manner in which ownership of the minerals was acquired: that is, in the case of minerals won, the number of the pratanabat shall be given, and, in the case of minerals purchased, the number of the purchasing license or sublicense held by the purchaser. (Sec. 17.)

It shall be lawful for any inspector to take possession and detain any minerals being removed from one place to another in contravention of the provisions of section 17 and to detain the same in a suitable place until the ownership of the minerals is established. If the owner of the minerals fails to appear within 15 days from the date of detention, the property in the minerals shall vest in the Government. (Sec. 18.)

No holder of a purchasing license or of a sublicense shall purchase minerals except (a) upon the production by the vender of a disposal note bearing at its foot the signature of a pratanabat holder and showing the number of the document and attesting that the minerals to be sold have been raised from the area covered thereby, or (b) upon the production by the vendor of a disposal note bearing the signature of the holder of a purchasing license and showing the number thereof and attesting that the minrals to be sold belong to the holder of the license, or (c) when the minerals offered for sale are in such quantity as to warrant the belief that they were obtained by washing and the vendor produces a mineral washing license. (Sec. 15.)

TIN AND TIN ORE RESTRICTION[17]

The tin and tin ore restriction act defines minerals, pertinent to the act, as "tin and tin ore and other minerals containing more than 4 per cent of pure tin." (Sec. 4.) Any tin ore won but not smelted, which ordinarily contains other elements, shall be deemed to contain 72 per cent of pure tin. (Sec. 5.) The opinion of the Government laboratory shall be final in any dispute as to whether a particular mineral contains more then 4 per cent tin. (Sec. 6.)

The act is divided into six main headings: (1) Part concerning mining, sections 9 to 13; (2) part concerning the sale and purchase of minerals within

17 The Tin and Tin Ore Restriction Act (Siam), B. E. 2474: Ministerial Regulations issued under section 39 of the Tin and Tin Ore Restriction Act, B. E. 2474.

the Kingdom, sections 14 and 15; (3) part concerning the export of minerals, sections 16 to 18; (4) part concerning the minerals in possession on the date of the coming into force of this act, sections 19 to 25; (5) part concerning procedure and punishments, sections 26 to 32; and (6) part miscellaneous, sections 33 to 39. The ministerial regulation (issued by the Minister of Lands and Agriculture August 21, 1931), under section 39 of the act, merely establishes a ninth customs station.

As the act under discussion is but a temporary measure, a brief summary of the more pertinent provisions follows.

Concerning Mining

No producer[18] shall mine unless he shall have obtained a certificate of production or a temporary certificate of production, and he shall mine only in accordance with the terms and conditions of the certificate. (Sec. 9.)

Certificate of production. - Application for a certificate of production[19] shall be made in the prescribed form to the district mines officer, who shall make a report to the Assessment Committee,[20] which in turn shall forward the production assessment to the district mines officer, that he may inform the applicant thereof in writing. If no objection is raised by the applicant, particulars of the quota[21] and quota period[22] shall be calculated, specified, and entered in a certificate of production in the prescribed form. (Sec. 10.) The quota period shall not exceed six months for any one period, and the first period shall be deemed to have commenced September 1, 1931. (Sec. 7.)

Temporary certificate of production. - A temporary certificate of production is a certificate authorized to be issued by the district mines officer in case an applicant for a regular certificate is dissatisfied with the assessment and appeals (in accordance with the provisions of section 11) to the Minister from the decision of the Assessment Committee. (Section 12.)

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18 Producer means the holder of a pratanabat under the provisions of the mining act, B. E. 2461. The holder of a mineral washing license shall not be considered a producer. (Sec. 4.)

19 Production means the quantity of minerals deemed to be extractable from any mine in any period of one year, as determined by the Assessment Committee in accordance with such rules as the Minister shall enact by ministerial regulations. (Sec. 4.)

20 Assessment Committee means the committee to be appointed by the Minister from time to time to assess the production of mines; it shall consist of not less than three members. (Sec. 4.) Three members shall form a quorum, and the opinion of the majority shall prevail. (Sec. 33.)

21 Quota means the restricted quantity of minerals expressed as a percentage of the production that any mine shall be permitted to win within a specified period.

22 Quota period means any period within which the quota may be won from any mine and disposed of.

Concerning the Sale and Purchase of Minerals

Minerals to be sold shall be limited, as follows (sec. 14):

1. Minerals sold under and in accordance with the conditions contained in a certificate of production or temporary certificate of production.

2. Minerals offered for sale by buyers.

3. Minerals offered for sale by a mineral washing license holder in such quantity as to warrant the belief that the minerals were obtained by him by washing.

Likewise all buyers shall purchase only (1) minerals the property of a certificate holder, (2) minerals the property of other buyers, or (3) minerals the property of the holder of a mineral washing license.

Concerning the Export of Minerals

A producer holding a certificate of production (or temporary certificate) may obtain from the district mines officer a certificate of registration as an exporter, provided the customs station through which he desires to export is one of the scheduled stations under ministerial regulations. (Sec. 16.) (Further details are found in sections 17 and 18.) If a registered exporter wishes to export through a station (scheduled in ministerial regulations) other than the one his certificate was issued for, he may obtain permission by applying to the district mines officer, who may grant such permission within the limits of the exporter's quota. (Sec. 36.)

Miscellaneous

The Minister is empowered to amend or suspend the operation of either section 32, referring to mining rent, or section 37, referring to working time and number of workmen, of the mining act, B. E. 2461, or both, in such manner as he shall think fit. (Sec. 8.)

MINERAL RESOURCES AND INDUSTRY

Mining is far less important than the rice industry in the national economy of Siam, but it does furnish the third largest item of export and is the principal economic support of the southern part of the Kingdom.[23]

Although many kinds of minerals (copper, coal, iron, lead, zinc, antimony, molybdenum, wolfram, gold, rubies, and sapphires[24]) have been found in Siam, tin is the only mineral that has ever been mined in important commercial quantities. The Government's revenue from the royalty on tin, fixed according to a sliding scale based on the market price, in recent years has amounted to approximately

23 Walstrom, Joe D., ______________________: Trade Com. Rept. 132325, Bangkok, May 29, 1931.

24 Hansen, Carl C., Annual Trade and Economic Review of Siam: Comm. Repts., No. 25, Jan. 31, 1921, p. 604.

3,250,000 bahts ($1,430,000) annually.[25] An amount closely corresponding to the revenue from royalties has been realized from rent, prospecting, and exclusive license fees.[26]

A brief résumé of the history of tin mining follows:[27]

> As in the neighboring country (British Malaya), Chinese were the first to mine tin from the rich deposits of this area. Their activities date back at least 200 years. Puket Circle, including the island of Puket and the western coast of the narrow neck of land that joins Siam to British Malaya, has been for many years the most important tin district. Deposits on the island, however, are being gradually worked out, and greater attention is given to prospects on the mainland. Tin is found also in Pattani (the eastern coast of the Siamese portion of the peninsula), in the vicinity of Surashtra, and more recently in Rajaburi Circle, in the extreme northern part of the peninsula. Approximately 140,000 acres are alienated for prospecting and mining tin under the mining law (which was promulgated in 1918). About 30 companies, chiefly British and Australian, are engaged in the enterprise, the small Chinese producer having gradually given away to the larger foreign companies. . .
>
> The average yearly production of tin ore is 130,000 piculs (7,735 tons). As a result of the impetus given the industry during the World War and the slump that followed, output varied for a time as much as 50,000 piculs (3,000 tons) a year. In the fiscel year 1927-28, 131,320 piculs (7,813 tons) of tin were produced. Practically the entire production is marketed in Penang and Singapore in the form of ore and is smelted in the form of ore and is smelted in those cities, since Siam's facilities are very limited . . .

According to Brookhart,[28] the operation of the international tin pool does not curtail Siam's production as drastically as it does the output in other areas. Siam's quota is 10,000 long tons of fine tin; Bolivia's, 28,000 tons; Netherland East Indies', 25,000 tons, Malaya's, 45,000 tons; and Nigeria's, 6,515.

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25 Pugh, M. A., Economic Development of Siam; Mineral Resources: Trade Inf. Bull. 606, U. S. Department of Commerce, 1929, pp. 21-22.
26 Walstrom, Joe D., ____________________: Trade Com. Rept. 132325, Bangkok, May 29, 1931.
27 Pugh, M. A., Work cited.
28 Brookhart, Charles E., Report of Acting Commercial Attaché, Bangkok, July 10, 1931, Min. Div., Bur. For. Dom. Com., file 133335.

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

PHYSIOLOGICAL FACTORS IN MINE VENTILATION IN 1931[1]

By R. R. Sayers[2]

The hazards connected with work under abnormal air conditions are becoming of increasing importance from a financial as well as a physiological standpoint, due to the extension of compensation laws to include diseases caused by dusts, toxic gases, and abnormal temperatures and humidities.

The United States, with the exception of California, North Dakota, Wisconsin, Massachusetts, and Connecticut, is the only English-speaking country to-day where silicosis is not compensated.[3] Cases of permanent total disability or death due to silicosis may appear in common-law courts, particularly in the States that have not recognized silicosis as an occupational disease for which compensation should be provided. Such cases have recently been tried in one State,[4] according to a magazine editorial, not providing scheduled compensation for employees affected by silicosis, with results favorable to the claimant. Clearly established cases definitely linked with occupation as the cause may be expected to be recognized as deserving by juries and courts, and awards will be made. In one Atlantic Coast State, according to this editorial, 108 claims for silicosis, including 21 deaths therefrom, are said to have been filed against two small plants engaged in finely pulverizing quartz sand.

1 - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6645."
Report of the Chairman of the Subcommittee on Physiological Factors of the Committee on Ventilation of the American Institute of Mining and Metallurgical Engineers, presented at the meeting in New York City, February, 1932.
2 - Chief surgeon, or chief, health and safety branch, U. S. Bureau of Mines; surgeon, U. S. Public Health Service.
3 - Hayhurst, E. R., Compensation for Silicosis: Jour. Am. Med. Assoc., vol. 97, No. 9, August 29, 1931, pp. 660-661.
4 - Industrial and Engineering Chemistry, Beware of Silicosis! Editorial, vol. 23, No. 10, October, 1931, pp. 1082-1083.

Under the New York compensation act, compensation claims in nine cases of carbon monoxide poisoning were granted and three disallowed during 1931, according to report of the New York State Department of Labor.[5]

The death of a workman from the inhalation of carbon monoxide in the course of his employment in a mine was, in the opinion of the court of appeals of Ohio,[6] due to an "accidental injury" within the meaning of the Ohio compensation act, and not to an occupational disease.

A review of the literature published since the last report of the effects on workers of injurious dusts, gases, and variations in temperature and humidity indicates the importance of such hazards from the physiological standpoint.

SUMMARY OF RECENT LITERATURE CONCERNING EFFECTS ON WORKERS OF EXPOSURE TO DUSTS

Dusts may be either poisonous--as lead, arsenic, and zinc--or nonpoisonous --as coal, silica, quartz, limestone, talc, asbestos, and dusts from similar substances. From the standpoint of health, with the possible exception of lead-dusts, the most important dusts are those causing various types of pneumoconiosis, although all dusts may be injurious if breathed in sufficient quantities for a long enough time. Investigations in the various countries during the past year were concerned mostly with silicosis, as indicated by the literature on dust diseases.

Australia.- In order to determine the incidence of fibrous pneumoconiosis among coal miners before rock-dusting had been in practice for any length of time, 471 volunteers from among miners with at least 10 years underground experience were examined by the Division of Inudstrial Hygiene of the New South Wales Government.[7] Of the men examined, 199 came from one mine, among the employees of which a number of cases of pulmonary fibrosis had occurred; the remaining 277 volunteers were employed in eight other mines of the district.

The miners were divided into four classes:

A. Men who had mined in coal only and in only one pit, in which they were working at the time of examination.
B. Men who had mined in coal only and only on the South Coast of New South Wales.
C. Men who had mined in coal only, but in other districts in Australia and elsewhere as well as the South Coast district.
D. Men who had worked in metal mines, quarries, etc., as well as in coal mines.

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5 - New York State Department of Labor, Industrial Hygiene Bulletin: Vol. 7, No. 11, May, 1931, pp. 41-42.
6 - Journal of the American Medical Association, Medicolegal, Workmen's Compensation Acts: Compensability of Carbon Monoxide Poisoning: Vol. 97, No. 26, Dec. 26, 1931, p. 1986.
7 - Moore, Keith R., Fibrosis of the Lungs in South Coast Coal Miners, New South Wales: Health, Commonwealth Department of Health, vol. 9, No. 5, May, 1931, 10 pp.

The men were classified according to length of mine experience and the percentages of men in each group who showed radiographic evidence of fibrosis, simple or complicated. No one in the group of men with 10 years or less experience showed evidence of fibrosis. The percentage of cases of fibrosis increased with length of exposure until the figure of 40.8 was shown for the group of men with over 30 years industrial history. The percentage for all man examined was 25.9.

The percentages of fibrosis among men with a coal-mining history only were fairly constant for the three classes A, B, and C, ranging from 22.5 to 25.7 per cent. The incidence in group D, men who had also done other classes of mining, was high--39.7--but this was accounted for, partly at least, by the increased proportion of older men in this group.

The percentage of fibrosis in men who had worked only on the South Coast was higher than in men who had mined coal in the South Coast and elsewhere in Australia or overseas, the average for classes A and B being 25.0 as against 22.5 per cent for class C.

The dust to which coal miners in class A had been exposed is that originating from the cutting of coal seams about 6 feet thick. The coal contains about 13 per cent of ash and not more than 2 per cent of free silica. The country rock is shale. In one mine the extraction of pillars caused very dusty conditions. A detailed investigation into the nature, size-frequency, and concentration of dust inhaled by coal miners has not yet been carried out.

In order to correlate the radiological with the clinical findings, 32 coal miners with varying degrees of fibrosis were examined clinically. The examinations revealed comparative freedom from symptoms and lack of gross physical signs in cases which showed apparent serious involvement radiographically.

The symptom most commonly complained of was shortness of breath (24 men), and the most frequently found sign was that of deficient air entry (12 men). Rhonchi were found in 10 men, one of whom was under treatment for bronchial asthma, and another for chronic bronchitis, while a third was drawing a military pension for "chest trouble." In two men only was there a history of the occasional appearance of streaks of blood in the sputum, and in both of these the radiographic diagnosis was simple fibrosis. They complained of sweating at night. Two others complained of pains in the chest.

A fine type of fibrosis of the lungs varying in degree from slight to marked was found to be present in 122 of 471 (25.9 per cent) coal miners examined, and the incidence among men who had worked on the South Coast coal field only was 25.0 per cent. This radiographic fibrosis was considered to be complicated by infectious processes in 49 of the 122 cases. Radiographic appearances of tuberculosis in the form of an acute lesion, a latent process, or an old scar were found in 24 or 5.1 per cent of the 471 men examined. The investigators reached the following general conclusions:

While it is evident from the radiographic findings that a pulmonary fibrosis may be produced by work in coal mines on the South Coast, it also seems that this fibrosis is of slower onset and the resulting disability less marked than in the fibrosis found in metal miners and workers exposed to dust with a high free silica content.

From the statements made above and the clinical examination of 32 men, the conclusion is drawn that the diagnosis of pulmonary conditions in these miners and the estimation of their disability must depend less on the radiographic findings than on the results of clinical examination.

Among the coal miners examined and still at work there is a higher incidence of simple and of complicated fibrosis according to radiographic evidence than among the metalliferous miners of Broken Hill and Tasmania, but a lower incidence than was found in metalliferous miners in Western Australia[8]; however, as the prognosis of the fibrosis of these coal miners is not known, this comparison is at present of no value.

Recent advances in radiological technique probably account in some measure for the definite X-ray appearance of slight to marked fibrosis in these cases. It is considered unlikely that all cases showing evidence of a complicated fibrosis are tuberculous, and even if tuberculous infection has been associated with these cases, it is active in very few.

It is highly important that this condition of fibrosis among coal miners should be placed on a sound pathological and chemical basis, and that every opportunity should be taken to study the pathology and histology of affected lungs to correlate the conditions found with radiographs taken before death, and to have full chemical analyses made.

To gain further knowledge of the cause of this form of fibrosis of the lungs it will be necessary to conduct inhalation experiments with animals.

According to the Queensland Government Mining Journal,[9] in a review of the position as regards lead absorption and lead intoxication at Mount Isa up to October 17, 1931, lead poisoning was found to occur among workers mining the ore in the carbonate stopes, tranporting the same on the haulage levels, and smelting the concentrates after treatment in the mill. Mild poisoning which responded rapidly to treatment was found in only three of the 145 underground workers examined. In the smelting section, 48 men of the approximately 260 examined manifested symptoms of lead intoxication, mild and transient in the majority of cases and of varying severity in a few. In a number of cases recurrences of the symptoms have been noted after return

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8 - Nelson, W. T., Report on an Investigation of the Pulmonary Conditions of Mine Employees, Western Australia, During the Years 1925-1926: Service Publication (Division of Industrial Hygiene) No. 5, Commonwealth Department of Health, Canberra, Australia.

9 - Queensland Government Mining Journal, Lead Poison Dangers, Mount Isa; Safeguarding Workers: November, 1931, p. 447.

to work. The longest period of acute disability under treatment was about four days in three cases. The treatment used is a removal of the poisoned worker from all chance of further ingestion, the allaying of acute symptoms by appropriate drugs, and the elimination of lead from the system after the acute stage has passed. The main objective is prevention by the installation of suitable exhausts and other dust-eliminating devices where the lead hazard is severe; provision and routine use by the men of respirator masks; ample and convenient water supplies for washing and drinking purposes, with an up-to-date change house under efficient supervision; provision of medicine, readily obtainable by the men; routine examination of the workers at regular intervals; and hospital treatment of poisoned workers, or in milder cases suitable out-patient treatment and observation.

According to the report there is a definite decrease in the incidence of lead poisoning, due primarily to the increased efficiency in lead-dust disposal, combined with the cooperation of the workers in better personal hygiene and in the early seeking of medical advice when in doubt about their health. All the workers now recognize the danger associated with the industry, the existence of which was unknown to the majority in the beginning.

In an anonymous article in the Engineering and Mining Journal[10] the statement is made that, although silicosis is inherently most difficult to combat, and will remain so while mineral-bearing material has to be drilled, blasted, and removed in confined spaces, plumbism, because it becomes manifest within a comparatively short period and has well-defined and easily recognized signs and symptoms, can be placed under control without loss of plant efficiency. As a matter of fact, if the remarkable result achieved at Port Pirie, Australia, be any criterion, then according to this article full success in the elimination of plumbism will give greatly increased technical efficiency. Since 1925, the problem of reducing the incidence of plumbism among employees of the Broken Hill Associated Smelters, at Port Pirie, has been continuously and thoroughly investigated. The plan of campaign has been to study the working conditions at each locality where a man who has contracted plumbism has been at work and to decide forthwith the alterations necessary to effect improvement. In many instances, these alterations have been simple and inexpensive, whereas in others a huge expenditure has been called for, particularly so when the improvement was primarily designed to advance metallurgical technic. This plan, administered by an industrial health department, has given success beyond all expectations. For the half year ended December, 1925, complete Government records show that 131 cases of plumbism prevailed among 2,615 employees, whereas for the corresponding period five years later, only eight cases prevailed among 1,500. Concurrently with the decrease in the number of cases, a diminution in the severity or period of disability of plumbism cases has taken place. Complete statistics are not available, but those that are available show that the average period of disability in 1929-30 amounted to only one-half that in 1927-28 and less than one-third that in 1926-27. For the half year ended January 14, 1931, the period of disability averaged 11 weeks,

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10 - Engineering and Mining Journal, Lead Poisoning Checked in Australia: December 14, 1931, pp. 488-490.

with a maximum of 15 weeks. The decrease in the period and in the incidence of plumbism among short-service employees makes evident the fact that the unhealthful working places, where employees were exposed to highly concentrated dust and fume, have been eliminated.

In summarizing, the article states that in stamping out a persistent health hazard within five years, the Broken Hill Associated Smelters, which to-day has an annual output of 175,000 tons of lead and 270 tons of silver, has made a remarkable achievement in industrial hygiene. Experience at Port Pirie has shown that in lead smelting the prevalence of dust and fume in and around localities where operatives are at work is certain to give rise to plumbism. Given adequate prevention and collection appliances for dust and fume, no man-handling of sinter and furnace charges and drosses, no dusty roads, no poorly operating smelting furnaces, and ample washing facilities, plumbism as a health hazard will not exist.

Austria.- Examination was made of 40 workers in an iron foundry in Vienna; 28 were moulders, 9 helpers, and 3 cleaners of castings; all had worked for more than 10 years. Four cases of pronounced and five of slight pneumoconiosis were found; three cases were doubtful. The author[11] compares the 7.8 per cent he found with the incidence of 5 per cent among porcelain workers and 28 per cent among coal miners having more than 10 years employment. The investigation indicated the necessity of improving hygienic conditions and careful attention to ventilation.

Canada.- Of 38 men engaged in the founding of bronze who were sent to the hospital for various complaints, 24 were found to be suffering from acute lead poisoning; 9 showed definite evidence of lead absorption; and only 5 showed no signs of plumbism. Bronzes of the type in question may contain up to 20 per cent of lead.

Blood smears of 26 men engaged in the polishing of low-lead brass and bronze (less than 6 per cent) showed that five had stippled cells, well in excess of 200 per million red cells.

The air in one foundry was found on analysis to contain a concentration of lead of about 0.85 milligram per cubic meter.[12]

England.- Captain Hay,[13] in a lecture entitled "Dust Prevention in Iron Ore Mines," did not discuss the health aspect but said that the following factors must be borne in mind in prevention of the dust hazard: The concentration of the dust in the atmosphere being breathed; the length of time of

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11 - Komissaruk, B., Pneumokoniose, Tuberkulose and soziale Verhältnisse bei Eisengiessern in Wien: Arch. f. Gewerbepath. u. Gewerbehyg, vol. 2, Berlin, 1931, pp. 123-39. Abstracted by Bull. Hygiene, London, vol. 6, No. 12, Dec., 1931, pp. 860-861.

12 - Pedley, F. G., and Ward, R. V., Lead Poisoning in Brass and Bronze Foundries: The Canadian Med. Assoc. Jour., vol. 25, No. 3, Sept. 1931, pp. 299-303.

13 - The Colliery Guardian, Dust Prevention in Mines: July 31, 1931, pp.371-72.

exposure to that dust; and the size of the dust particles. He said that the risk from iron-dust was negligible as compared with the dust containing a large proportion of free silica.

Cummins[14] in a paper on coal miners and tuberculosis considers the question of how it happens that coal miners, a class now recognized as sufficiently exposed to injurious dusts to develop a fairly high percentage of silicosis, and a class exhibiting a high death rate from other respiratory diseases, are notorious for their low death rate from tuberculosis.

After reviewing some of the literature on the subject, he makes the following statement:

> Recent observations by the writer and Dr. Weatherall have proved that coal-dust in fine division can adsorb and inactivate tuberculin solutions to a marked extent; and the writer tends more and more to the view that it is in this direction that the relative exemption of coal miners from tuberculosis is to be explained. When it is recalled that the lungs of silicotic and anthracotic coal miners may contain over 100 grams of coal-dust, as shown by Cummins and Sladden in their recent work, it will be readily conceded that the available adsorption potential of carbonaceous matter in silico-anthracotic lung tissues may be very great.
>
> It must not be supposed, however, that the presence of accumulated coal-dust in the lungs is an unmixed blessing. On the contrary, it may have very disagreeable or even dangerous results. While it seems to have a definitely beneficial effect in lessening the liability to the extension of tuberculous lesions it may, by its mere accumulation, come to occupy large areas of lung tissues to an extent which leads not only to fibrosis and devascularization, but sometimes to colliquative changes and even cavity formation. With these changes there is brought about, to a gradually increasing extent, a state of lung emphysema accompanied by structural deterioration of alveolar tissue, bronchioles and even bronchi which involves serious interference with the function of respiration.
>
> Most old coal miners are dyspnoeic. Although many of them work on to a great age, they are, as a rule, "short of breath" and suffer from copious sputum, cough and sometimes asthmatic trouble.
>
> While the collier is fortunate in having a relatively low death rate from tuberculosis, his death rate from "bronchitis" is very high.
>
> Whether the word "bronchitis" is well chosen to describe the dyspnoeic state in which old coal miners so commonly die is open to question; and it is a question, too, whether they merely die dyspnoeic or die from dyspnoea. Certain it is that the effects of stone-dust and

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14 - Journal of State Medicine, London, Coal Miners and Tuberculosis (A Paper read at the Frankfurt Congress): Vol. 39, No. 9, Sept., 1931, pp. 526-36.

coal-dust combined tend, after a life spent in the industry, to produce a state in which the breathing efficiency of the lungs is seriously compromised.

Haldane lays stress on the hard muscular work involved in coal-getting as an important factor in the production of chronic bronchitis and emphysema. It would be rash to minimize the possibilities of hard muscular work as a cause of emphysema. The histological and pathological examination, however, of the lungs of coal miners dying at different ages and stages of industrial exposure to mixed coal and stone dusts shows that, quite apart from any possible effect of inordinate muscular effort, there exists a condition of pneumonoconiosis which is in itself sufficient to account for the dyspnoea and bronchitis from which old coal miners suffer.

The fact that the apex of the curve of "bronchitis" mortality in coal miners occurs so late in life shows that the state of lung injury above described is often consistent with survival to a ripe old age. It does, however, involve marked respiratory distress and considerable loss of health. This pneumonoconiosis of coal miners is at least a contributory cause in many of the deaths attributed to 'bronchitis' and it appears, in itself, to lead to a fatal issue in some cases. The attitude of complacency commonly assumed toward the risks run by coal miners from exposure to the mixed dusts of the coal mines is obviously unjustifiable.

Coal mining involves a definite risk of pneumonoconiosis. While it is true that the silicosis which the collier develops is not usually associated with increased liability to tuberculosis, it does lead to a marked and potentially injurious accumulation of coal dust in the lungs. Everything possible should be done to minimize this risk. Two valuable lines of prophylaxis are open to further investigation. On the one hand there is the closer study of the constituents of the stone-dusts used to diminish the danger of explosions. Much more accurate knowledge is needed as to what percentage of silica may be regarded as safe in this connection. The value of stone-dusting needs no emphasis. It must continue. But the selection of the stone used for the production of the dust is clearly a matter of the greatest importance and further research as to limits of safety in each of the constituents of such stone-dust is urgently required.

Ellman[15] in reporting a case of pulmonary asbestosis stated:

In my cases the onset of symptoms has usually been about five years after exposure to the dust, beginning with a cough, with little expectoration, and accompanied by dyspnoea, both of which become progressively worse. There is always some wasting, sometimes quite marked, and the physical signs are usually those of a basal fibrosis to begin with, followed by extension of the infiltration upwards, but affecting mainly,

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15 - Proceedings of the Royal Society of Medicine, Pulmonary Asbestosis: Vol. 24, No. 5, March, 1931, pp. 526-28.

as in Dr. B. Wood's cases, the lower and middle zones. The heart and mediastinum are drawn over to that side where the degree of fibrosis is most marked. The adventitious sounds are of a dry, crackling nature, and are probably due, to a large extent, to friction from the accompanying pleurisy.

In the case now shown there is a suspicion of an annular shadow in the left infraclavicular region, suggestive of a cavity. The asbestos fibres have strong penetrating qualities, and commonly penetrate the skin of workers, producing asbestos "corns." Gloyne has shown that asbestos fibres can be removed from the corns with a fine needle. The characteristic golden yellow asbestos bodies may be found in the skin, sputum and lung. The prognosis, when the disease is established, is, on the whole, bad. Tuberculosis is not usually a terminal condition as it is in silicosis. Many patients die from an ensuing bronchopneumonia, and post-mortem examination has shown no evidence of tubercle. When there is persistent absence of tubercle bacilli and a history of prolonged exposure to the dust, with signs and symptoms already outlined, a diagnosis of pulmonary asbestosis can be made.

According to Cooke,[16] so far as can be ascertained no case of pulmonary asbestosis has been recorded in a worker in iron-free asbestos such as has occurred in Arizona, Italy, and Finland. The point is of considerable importance in the explanation of several phenomena observed in the chrysotile worker. Specimens of iron-free asbestos do not show the blue, black, or brown particles seen in chrysotile. He describes the action of asbestos as follows:

> Sections of the lungs and the results of digestion of the lung with trypsin show an enormous amount of fine black granular dust. In addition there are two striking features. The first is the almost complete absence of the very fine translucent spicules of fibre which make up the great proportion of dust in factories. This point will be referred to later. The second feature is the presence of large fragments varying in length from 10 to 360 microns. They are found in fibrotic and necrotic areas, singly, and in groups. The particles are so large--masses of them are seen in some sections--that they must have occluded small bronchi and resulted in fibrosis of the surrounding area. Comparing these large particles in the lung with those found in asbestos-dust the close resemblance in sizes, shapes, and colours is apparent. There are the same black, blue, brown, and translucent fragments. In fact it is easy to take each single particle from the lung and immediately find its brother in a slide made from the dust.
>
> In true silicosis, particles of this size are never found, and I have not seen particles approaching these dimensions in any condition except in a case of pneumonoconiosis due to flue-dust. The insoluble siliceous matter in flue-dust contains in addition to quartz grains many acicular crystals and flat plates--transparent

16 - The Journal of State Medicine, London, Asbestos Dust and Asbestosis Bodies from the Lungs of an Asbestos Worker (A Paper read at the Frankfurt Congress): Vol. 39, No. 9, Sept., 1931, pp. 544-48.

and opaque--of micaceous and felspathic origin. The dust contains 27 per cent of iron as ferric oxide and much of the siliceous matter is colored red from its presence. In sections, and after digestion of the lung in this condition, large particles similar to those found in the asbestos case were found.

Asbestos as a pathogenic agent would appear to act in two ways. The first, as a direct mechanical irritant, is suggested by the large amount of fine granular dust, the larger angular particles, and the presence of much fibrous tissue with multinucleated giant cells not associated with an endothelial and round cell system in sections of the lungs. The presence of acicular crystals can not be ignored as a source of mechanical irritation. The bases of the asbestosis bodies, and these are multitudinous--sharp spicules of asbestos fibre, biotite, and magnetite 20 to 100 microns in length--must have some mechanical action. These bodies are very readily phagocyted and, although some chemical action certainly exists, one can not overlook the mechanical effect of the particles in the production of fibrosis.

Secondly, chrysotile acts as a pathogenic agent because of its soluble constituents. Race states that from commercial asbestos (presumably chrysotile) silica was extracted by a modified Ringer's solution after eight months to the extent of 28 parts per 1,000,000. We have the almost certain proof that some soluble fraction of asbestos plays a part in the formation of the asbestosis bodies, and Race's observations suggest that chemical action must play a not inconsiderable part in the production of the pulmonary fibrosis.

Tylecote[17] describes a case of asbestos-like bodies in the lungs of a coal miner who had never worked with asbestos. The man said that when young he had worked in mines in Alabama. No asbestos is found in Alabama, which is noted for coal and iron. According to the author -

The main point of interest in the case is the occurrence in the lungs of bodies which somewhat resemble those that have been described in the lungs of asbestos workers. They simulate these in size and general shape, especially in the rounded swellings at the ends; in colour; and in their abundant content of free iron. They differ from the familiar asbestos bodies in being usually coarser and less regular, in possessing a black core of opaque material, and in the absence of any appearance of segmentation. It is presumed that they are minute fragments of some other iron-containing mineral, which have been inhaled into the lungs and undergone some chemical change under the influence of the tissue fluids resulting in the formation of a peripheral lamina from the iron-containing part. They do not appear to have caused a very serious fibrous reaction in the lungs in this case.

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17 - The Lancet, Case of Asbestos-Like Bodies in the Lungs of a Coal-Miner Who Had Never Worked in Asbestos: Vol. 221, No. 5638, Sept. 19, 1931, pp. 632-33.

The attention of Parliament[18] was called to an inquest of a young woman who had been employed eight years before at an asbestos factory, the verdict being death due to asbestosis accelerated by tuberculosis. A statement was made that the scheme for the asbestos industry does not apply to persons who were not employed in the industry at the time the scheme was made, and that no compensation, therefore, would be payable in the case.

The Home Secretary was asked[19] for the number of workpeople engaged in the asbestos industry who had been examined by members of the medical board, the number of workpeople found to be suffering from asbestosis, and the number of workpeople suspended from work in the industry by the medical board. The reply was made that 582 workers had been so far examined by the board; three had been found to be suffering from asbestosis, of whom one had been certified as totally disabled and two had been suspended. In addition, one worker had been suspended on account of tuberculosis and one on account of defective physique, making a total of four workers who had been suspended. In 77 of the cases examined the result of a radiological examination was being awaited.

According to the report of the Chief Inspector of Factories and Workshops[20] for 1930, by a recent arrangement the factory-inspection service receives copies of all death certificates in which death resulted from pulmonary disease involving fibrosis of the lungs. Of the 700 such certificates received in 1930, 241 gave silicosis as the cause of death, and in the great majority of cases it was found that the previous occupation of the persons concerned was one in which there was recognized exposure to silica-dust. The industries furnishing the greatest number of such cases were pottery manufacturing; the sandstone industry, industries employing quarrymen and stonemasons; coal mining; gold mining (ex-South African miners); refractories industries; sand blasting; and tin mining.

The report also stated that recent investigations of the effects of exposure to asbestos-dust have resulted in the adoption of measures to control the dust in the textile side of the asbestos industry. Data regarding 20 fatal cases of asbestosis without tuberculosis show that there is a serious hazard involved in continued exposure to heavy concentrations of asbestos-dust. Of the 20 cases, 6 were mattress makers and 6 were carders or cloth weavers, while the remaining cases, it appeared, had been exposed to neighboring dusty processes such as carding and cloth weaving. There is evidence, also, that although removal from exposure to very dusty processes may greatly delay the appearance of a disabling fibrosis or may prevent it entirely if the exposure is not too long, exposure to heavy concentrations of asbestos-dust for a comparatively short period of years will result sooner or later in the

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18 - The Lancet, London, Woman's Death from Asbestosis: Vol. 221, No. 5640, Oct. 3, 1931, p. 775.

19 - The Lancet, London, Asbestosis: Vol. 2, 1932, p. 1385. (Parliamentary Intelligence.)

20 - Industrial Diseases and Poisoning in British Factories, 1930; Silicosis and Asbestosis: Safety Engineering, Dec., 1931, p. 354.

development of a disabling fibrosis. The average age at death of the 20 cases was 38.9 years, and the average length of employment was 14.9 years.

In a brief summary of recent information regarding certain of the pneumoconioses other than silicosis, Collis[21] calls attention to some of the respiratory diseases that may be caused by dust but are seldom recognized as dust diseases. The inorganic dusts he classes as insoluble, soluble and harmful, and mixed. Under the heading of insoluble dusts he mentions that those from certain materials, such as basic slag and emery, which is an oxide of aluminum, are insoluble in the tissues. Inhaled particles fall on the walls of the bronchi and bronchioles, where they are entangled in secreted mucus, and then swept back by ciliary action to be expelled finally in sputum. If the dust exposure is sufficient in amount and in time, an inflammatory hyperemia of the walls results, with an excessive exudation of mucus; finally the process extends beyond physiological elasticity; then occur degeneration and destruction of the ciliated mucosa. Microbic invasion follows, and chronic bronchitis is established.

The process described occurs as a reaction to the inhalation of all dusts which are not rapidly absorbed; hence bronchitis stands out as chief of the dust diseases. During middle life it causes much recurrent invalidity and incapacity, and, after middle life is passed, high death rates.

But dust bronchitis can not clinically be distinguished from bronchitis conduced to by exposure at hot furnaces or to fumes in industry, or by severe climatic conditions; hence its association with dust inhalation tends to lack recognition.

Should the dust particles be small enough, 5 microns or less, to be drawn into the finer bronchioles and alveoli, which are the seat of attack for pneumococci, a similar reaction is stimulated; hence the resistance of these parts to infection is lowered, and pneumonia results. Pneumonia is even less recognized as a dust disease than is bronchitis; nevertheless, mortality records of those whose employment subjects them to dust exposure exhibit the fact that death rates from this cause are high.

When, however, fine particles of insoluble dusts are carried on, by phagocyting dust cells, from the alveoli into the lymph stream and lymph nodes of the lungs, they tend to remain there as foreign bodies which do not provoke any particular tissue reaction.

In regard to the soluble and harmful dusts, Collis says that the most studied dust in this group is that of silica. Next come the dusts of silicates; recent work has established that although many silicates, such as fire clay and pottery clays, exert little if any harmful influence upon the lungs, certain other silicates, such as basalt and asbestos, react injuriously with the pulmonary tissues. The reason for these differences is not clear;

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21 - Collis, E. L., Occupational Dust Diseases: Bull. of Hygiene, vol. 6, No. 9, Sept., 1931, pp. 663-670.

but probably it lies in the constitution of the various silicates, the SiO_2 radical being less firmly attached to the molecule in some cases than in others.

He defines asbestosis as a pneumoconiosis which advances to a fatal end without the supervention of any characteristic infection; it is a simple dust condition, just as is simple silicosis; but it is more distressing in life and more rapid in its progress than is silicosis. It contrasts even more strongly with pulmonary mycosis, which is due to a living infection upon otherwise healthy lungs.

Of the mixed dust he says that so long as any dust consists of one substance only, its influence can be isolated and studied; but the case is different when more than one substance is present in the dust. Coal-dust, which has recently been carefully investigated, is here taken as an instance in point. No undue mortality from respiratory diseases is found among coal miners, so long as the coal worked contains little or no mineral matter--presuming, of course, that the miners are not exposed to other dusts, such as those arising from rocks intervening in the coal measures; of this fact miners on the Nottinghamshire coal field are an example. The lungs of these men may be as black as the coal they work, but they remain resilient and free from fibrosis.

According to Kettle,[22] in Great Britain the dust risks are shared by a number of industries scattered throughout different parts of the country, which makes it difficult to obtain comprehensive morbidity and mortality statistics, but there can be no doubt that industrial pulmonary disease will be of greater importance in social and medical legislation in the near future. He calls attention to the fact that, roughly speaking, the industries in which there is a dust hazard employ twice as many Europeans as the Rand mines and, if the unknown proportion of the huge population of coal miners is included, the question becomes very serious. He also points out that in pulmonary disability, such as miner's phthisis, potter's asthma, grinder's rot, chalicosis, and siderosis, the terminal pathological condition is always the same and the victims die with advanced pulmonary tuberculosis. He therefore considers that pathologists are confronted by two main problems: First, how does silica affect the lung, and how may its action be prevented or modified? And secondly, how does it influence the development of pulmonary tuberculosis?

In regard to the action of silica on the lungs, Kettle mentions that it is now generally accepted that dust inhaled into the terminal alveoli is phagocyted by the pulmonary macrophages and transported to various parts of the lungs, where it presumably gradually becomes dissolved and in the soluble state stimulates the growth of fibrous tissue. He is impressed by the difference in behavior of quartz when it is introduced into the lungs by way of the air passages, and when it is introduced directly into the tissues by subcutaneous inoculation. In the one case it is ingested by phagocytes, which

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22 - Kettle, E. H., Relation of Dust to Infection: Proc. Roy. Soc. Med., vol. 24, No. 1, London, pp. 79-94. Nov., 1930.

may remain quiescent in the pulmonary alveoli for long periods without signs of tissue reaction; in the other, necrosis of the tissue takes place within hours or days and there is an active inflammatory reaction. Presumably fibrosis can occur only if silica is brought into direct contact with fibrous tissue or cells capable of forming it. Kettle is of the opinion that the various stages in the development of pulmonary silicosis have not been fully worked out. He doubts the truth of the statistics indicating that workers in certain dusty trades, although exposed to a high percentage of silica, do not suffer from silicosis. He states that whatever may be the explanation of the relative immunity of the coal miner to tuberculosis, if such immunity really exists, it can not be the absence of silicosis. In his opinion the experiments that have been accepted in the past as having significance are incapable of giving the required answer; there must be a base line to work on--that is, the production of characteristic silicosis in animals--and in the absence of this we are not justified in claiming experimental knowledge of how silicosis may be modified.

In regard to the effect of silica on pulmonary tuberculosis, Kettle[23] says that although silica may itself produce profound changes in the lungs, industries are now so controlled that workers are rarely choked with dust; they inhale a certain amount of silica, which may produce a fairly advanced fibrosis of the lungs, but the chief danger lies in the influence of the dust on microbic infection. He mentions experiments by Gardner as well as by himself which seem to indicate that with silica-dust, although it does not affect the total growth of the tubercle bacillus, the lag period seems to be shortened so that abundant growth is obtained in a much shorter time when silica is added to the medium than when it is absent.

Haldane,[24] referring to statistics compiled in England in recent years concerning occupational mortality, says that, since the inhalation of siliceous dust leads to tubercular infection of the lungs, with great development of fibrous tissue, deaths from silicosis are nearly all returned as due to phthisis or tubercular lung disease, but that there is clear evidence that the inhalation of siliceous dust leads, or may lead, to deaths returned as due to bronchitis. Although bronchitis is not silicosis, a high bronchitis may be associated with silicosis as well as with inhalation of various sorts of dust. He also states that, although available statistical evidence does not show the existence of any silicosis among coal miners, other direct evidence has shown in recent years that in exceptional circumstances very great risk may occur among men driving roads through sandstone or other highly siliceous rock. However, he evidently attributes the high mortality among coal miners from bronchitis to the severe muscular exertion rather than to the inhalation of coal-dust. The chance of death from bronchitis is about seven times as great among the more or less unskilled who work mainly with their legs and arms, as among the classes whose occupation involves but little hard muscular work. He concludes, from the fact that functional efficiency increases, that presumably a collier's or a cement worker's lung becomes more efficient as

23 - See footnote 22.

24 - Haldane, J. S., Silicosis and Coal-Mining: Trans. Inst. Min. Eng., London, Feb., 1931, pp. 415-451.

regards its phagocytic activities than the lung of a person not exposed to dust; and this accounts for the relative immunity to phthisis of a coal miner or coal-boat loader or cement worker. He supposes that some soluble constituent in the dust stimulates the phagocytes to activity and that this substance is present in coal-dust, shale-dust, clay, and various other kinds of stone which are not harmful. He found that the Registrar-General's statistics showed a higher bronchitis death rate among anthracite miners, although there is no rock-dusting in the district, and thought that possibly the anthracite-dust is in some way more irritating or penetrates more readily than ordinary coal-dust. Haldane summed up his conclusions as follows:

> Neither the Registrar-General's statistics nor any other evidence whatsoever shows that any class of work in coal mining is subject to risk from silicosis except under very exceptional conditions that can be guarded against effectively. Nor is there any clear evidence that dust inhalation by coal miners is an ordinary cause of either bronchitis or pneumonia among them, although it seems practically certain that excessive inhalation of coal dust or shale dust must cause bronchitis, and ought therefore to be avoided.

In the discussion of his paper Haldane made the following statement in regard to X-ray diagnosis of silicosis:

> This paper, although it is about coal mining, has a good deal of bearing on metalliferous mining as well. It has been shown lately that when healthy coal miners are examined with the X-rays, a good many of them present a picture which can not be distinguished from the picture seen in the case of the Johannesburg miners. If a man in the mines at Johannesburg presented such a picture, it would be regarded as sentence of death, but this picture seems to be found in this country among coal miners who are fairly healthy. I want to make a strong protest against the practice of diagnosing silicosis on mere X-ray examination without knowledge of the man's history and of the kind of dust he breathes. One is apt to get into the hands of X-ray specialists who diagnose silicosis in all sorts of cases. There is a considerable tendency at present to say that working in stone is a dangerous occupation, when it is not dangerous as a general rule, although it may become so in certain definite circumstances. Recent legislation seems to invite endless compensation litigation, in the midst of which there is a possibility that the real cases of silicosis may be missed entirely. It would be very difficult for a doctor--say, in panel practice--to affirm that a case is not silicosis; there would be a natural tendency to give patients the benefit of the doubt. I look with some apprehension on regulations that are being introduced on this subject; at all events, they call for great skill and care in administering them, and for greater knowledge than to-day exists among a number of the specialists.

Wynne,[25] in the course of the discussion of Haldane's paper, asked whether it is possible for an accurate diagnosis of silicosis to be made before a man dies, and mentioned a case from a pottery district in which a man had been working all his life and, from his industrial history, could not have been anywhere near rocks containing any appreciable or dangerous proportion of free silica, or engaged in any processes likely to be dangerous. Unfortunately in view of the unanimous opinions of the three doctors in certifying him to be suffering from silicosis, the coroner decided that a post-mortem was unnecessary.

The following statement was made by Jones[26] during the discussion:

> With regard to X-ray photographs, I think I am right in saying that on the Rand, of the cases which have been subject to a post-mortem examination, over 30 per cent of those which had been diagnosed solely on X-ray photographs have been proved to be wrong; and that a large amount of money had been paid in compensation which need not have been paid. Just before Christmas I heard of a case in which a man was said to have died of silicosis, but on going through his history it was found that this man had never worked in any rock containing more than 40 per cent of free silica. On port-mortem examination, however, the man was found to have actually suffered from silicosis. In that case the X-ray examination was backed up, but owing to legislation no compensation could be claimed by the relatives of the deceased.
>
> The question of anthracite-dust is rather interesting. I might refer to one case in which a death occurred, and the verdict of "natural causes" was returned at the inquest. The doctors regarded the death as due to some bronchial trouble, but on post-mortem examination this man, who had been working on the screens at an anthracite colliery, was found to have a tremendous amount of anthracite-dust in his lungs; his lungs were full of dust, yet the medical people said that that was not responsible for his death.

According to Collis[27] figures for bronchitis differ widely, and in order to accord with the somewhat novel idea advanced that liability to bronchitis depends upon muscular exertion, would require that the muscular work done on the Nottinghamshire coal field should not only be far less than on the Lankshire and South Wales fields, but also less than the standard set by occupied and retired males. The data, according to Collis, can hardly be claimed to be in support of the "muscular exertion" theory of bronchitis among coal miners; hence the final conclusion of Haldane seems to be reinforced that "it seems practically certain that excessive inhalation of coal-dust or shale-dust must cause bronchitis, and ought therefore to be avoided."

25 - See footnote 22.
26 - See footnote 22.
27 - See footnote 22.

A case is reported by Edwards[28] of a man aged 32, who had been a gravedigger for 17 years. He died from what was manifestly silicosis associated with tuberculosis. During his work he had to make graves in red sandstone, and pneumatic drills were often employed for this purpose; in dry weather the work was so dusty that he and his colleagues were able to work for periods of only 20 minutes.

A preliminary study, confined to the examination of men in working health and intended as a basis for any subsequent investigation into the radiographic appearances in the chest diseases of coal miners, was carried out by three selected teams of the medical staff of the Welsh National Memorial Association.[29] Chest radiographs of healthy coal miners were compared with those of persons not exposed to coal-dust. The following general program of work was carried out:

1. To discover, by the examination of coal miners (preferably over 40 years of age) who have been working as hewers for a period of 15 years or over, but excluding men who have worked in hard headings, whether they show abnormal X-ray appearances, these appearances, nevertheless, being consistent with ability to work.

2. To ascertain whether, in the case of coal miners of the foregoing groups, abnormal X-ray appearances are found to be associated with alterations in chest expansion and general physique; or with alterations in vital capacity where facilities for recording the latter are available.

Groups of healthy coal hewers from anthracite collieries, steam coal collieries, and semibituminous collieries to be studied in relation to the following points:

Details of Employment.-- (a) Duration of employment as worker in coal. (b) Capacities in which employed, with length of time: dusting, hewer, etc. (c) Kind of coal worked, e.g., semibituminous, steam, anthracite.

Physical Records.-- (a) Standing height without boots. (b) Chest measurement at nipple line in full expiration and full inspiration. (c) Weight in shirt and trousers. (d) Spirometer records where obtainable.

Standardized X-Ray Technic.-- (a) Position of patient: standing with tube to back, arms drawn forward and rotated inward to remove shadows of scapulae. (b) Phase of respiration: partial inspiration.

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28 - Edwards, P. W., Silicosis in a Gravedigger: Lancet, vol. 1, 1931, pp. 1238-1239.

29 - The King Edward VII Welsh National Memorial Association. Coal Miners' Lung; A Radiographic Study of Certain Groups of Industrially Healthy South Wales Coal Miners: Jour. Ind. Hygiene, vol. 13, Jan., 1931, pp. 19-45.

(c) Position of tube: focus of tube centered at level of third chondro-sternal joint. (d) Film target distance: 30 inches, approximately (duplicate at 36 inches in certain type cases). (e) Spark gap: 4 inches, approximately. (f) Current: 20 milliamperes. (g) Exposure: will vary with thickness of patient. (h) Screen: double intensifying to be used. (i) Films: kodak-contrast. (j) Developer: kodak. (k) Fixing: kodak. (l) Time and temperature of developer: approximately six minutes at 65°F.

The following is a general summary of the results of the comparison of the four groups--three groups of coal miners and one of the agricultural workers:

The mottling present in the anthracite workers is over twice that in the workers in steam coal, and it seems probable that further research will be necessary to elucidate the cause or causes of such a marked difference.

From these investigations and comparisons it seems certain that within the span of a miner's working life and while he still retains what may be called working health, exposure to the dust of the coal mines, and, perhaps, especially to the dust of the anthracite coal mines, leads to marked alterations in the lungs, visible in X-ray films and comparable, in many respects, to the alterations regarded as characteristic of silicosis. That such appearances are consistent with working health is a fact which has a very important bearing upon the interpretation of radiographs in cases of pneumonoconiosis.

With prolonged exposure to the inhalation of coal-dust and the dusts associated with it in the mines, and with the development of lung fibrosis as seen in X-ray films, there goes a tendency to a gradual deterioration which, though insufficient to lead at once to industrial disability, becomes apparent in diminished chest expansion, lowered vital capacity, and some loss of weight.

The data for the South Wales coal field are subdivided into three districts which comprise: (a) the eastern or Monmouthshire area, wherein most of the coal got is soft bituminous or house coal; (b) the mid or Glamorgan area, wherein most of the coal got is steam coal; and (c) the western area, wherein a large proportion of the coal is anthracite.

Hewers or coal getters, at least on the South Wales coal field, are mainly exposed to the dust arising from the coal they work; as will be seen in the Team reports, however, they may sometimes perform duties which involve exposure to stone-dust as well. Mortality records for pulmonary diseases among hewers employed in the three areas of South Wales may be claimed, in so far as they differ from each other, to give some indication as to whether dusts from the three types of coal named exert different pathologic effects.

The standardized mortality figures for these three areas indicate that English coal miners on an average suffer decidedly less than the standard set by occupied and retired males from respiratory tuberculosis, about the same from pneumonia, but definitely more from bronchitis. When the three South Wales areas are considered, the western area, that reported on by Doctor Jordan and Doctor Clark, is found with figures for each of the diseases not only above those for the other two areas, but above those for all the other fields, and for occupied and retired males, the excess being greatest for bronchitis.

An excess of bronchitis, when compared with that experienced by all occupied and retired males taken as a standard, is found among coal hewers aged 45 years and over. This excess is most pronounced in the western group, while the Glamorgan hewer suffers more than his colleague in Monmouth from this cause of death.

Coal hewers of the western group experience an excess death rate from pneumonia at ages 45 to 75. An excess for the Glamorgan and Monmouth hewers is present only at ages 65 to 75.

Although, as is usual for coal miners, the three groups of coal hewers experience no excessive death rate from respiratory tuberculosis, a slight excess is present for the western hewers.

In the absence of any other contributing influence, the trend of these records would support a contention that occupational exposure to dust from anthracite coal mining exerts a definitely injurious effect on the lungs, which increases with age, and expresses itself particularly in mortality from bronchitis and to a less extent in mortality from pneumonia and from respiratory tuberculosis. Dust of mining in bituminous and semibituminous coal does not appear to exert this influence to the same degree, although some undue mortality in late life from bronchitis is associated with it.

Germany.- Flatzeck-Hofbauer,[30] director of the hospital for the care of the tubercular patients in Bavaria, in the center of the porcelain industry, although assuming with other authors that pneumoconiosis appeared relatively less frequently among granite workers than among sandstone workers, decided to determine whether "severe" dust-lung diseases were present in general within the meaning of the law in regard to the sandstone industry. He was able through the local labor organization to examine 10 very old granite stone cutters. Of these men who had occupational history of having worked from 31 to 49 years in granite only, one showed "moderately severe" and another "moderately severe to severe" silicosis. With the other seven the degree of silicosis present had to be considered more or less definitely as "severe." In five of these seven there was definite complication with tuberculosis.

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30 - Flatzeck-Hofbauer, Alfred, "Severe" Occupational Dust Lung Diseases: Zentralb. Gewerbehyg. u. Unfallverhütung, vol. 18 (new series, vol. 8), No. 5, May, 1931, pp. 116-119.

According to the author, this frequency of lung tuberculosis (dust-lung tuberculosis) among old granite stone cutters should be a completely valid proof of the danger of breathing granite-dust and must be considered as indicating without doubt that dust-lung diseases qualifying for compensation are present among granite stone cutters also, and not among sandstone cutters alone, as the severe tuberculo-silicotic total diseased lung condition is similar to the severe dust-lung diseases (without tuberculosis) that come under the decrees of the Government insurance office.

Menslage[31] calls attention to the fact that injury to health can occur through the purely physical action of the large amounts of dust arising during the utilization of all kinds of abrasive substances. The really injurious silicosis can appear as a rule only with the use of natural sandstone; the dust of artificial abrasives, due to their extremely small content of free silica, is not in a position to cause silicosis. This is of interest for the prevention of accidents (prevention of occupational diseases) as well as for the fixing of compensation. In regard to the first, it is to be considered whether the spread of silicosis can be reduced through the substitution of artificial abrasives for natural stone. In regard to the latter, physicians, insurance carriers, and compensation courts must consider together the question as to whether silicosis is present among the polishers, also the kind of abrasive used.

After an exhaustive survey of the work on pulmonary asbestosis in other countries, Krüger, Rostoski, and Saupe[32] give an account of the work done in Germany, together with a short statement of cases of the disease coming under their own observation in Dresden. They state that -

> The first record in Germany was a demonstration by Fahr to the Medical Society of Hamburg in 1914 of specimens and photomicrographs of a case of pneumonoconiosis in an asbestos worker. Fahr mentioned the occurrence of a large number of crystals in the lung but did not describe them more closely. He stated, however, that they had been seen by Marchand and Riesel in 1906, who had speculated as to whether they were due to the inhalation of asbestos dust or were a haemoglobin derivative. In 1931 Büttner-Wobst and Trillitzsch described nine cases occurring in two asbestos factories near Dresden. Meanwhile the authors of the present paper had begun to collect cases. They have now examined 52 (18 male and 34 female) workers, of whom 30 showed definite lung changes. A short analysis of the history of these cases is given. The longest exposure to the dust was 31 years in a worker aged 60.

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31 - Menslage, ___________, Danger to Health Through Abrasive Dust, with Special Consideration of Artificial Abrasive Substances and Silicosis: Zentralb. für Gewerbehyg. u. Unfallverhütung, vol. 18 (New series, vol. 8), No. 5, May, 1931, pp. 123-125.

32 - Kruger, E., Rostoski & Saupe, Ueber Lungenasbestose: Arch. Gewerbepath. u. Gewerbehyg., vol. 2, Berlin, 1931, pp. 558-90. Quoted from Ind. Hygiene, vol. 6, p. 361, Dec., 1931.

Beintker[33] records two cases, with post-mortem examination, of pulmonary asbestosis occurring in a factory concerned with the crushing, cleansing, and spinning of asbestos and the manufacture of insulating materials. He reached the following conclusions from these cases:

> Asbestosis of the lung differs from silicosis in its radiological picture as well as in anatomical findings in that the connective tissue increase is very diffusely distributed. It is arranged in nodules in silicosis, whereas in asbestosis it is distributed diffusely throughout the lung. The actual morbid anatomy picture appears to depend upon the distribution of the asbestos fibres in the lung tissue, and it is assumed that the asbestos fibres which gain access to the tissues probably do not begin their development into bodies until they reach the tissues. They are apparently the accumulation of the silica-containing material. The author believes that the X-ray picture in all types of silicosis, including asbestosis, depends not so much on the quantity of the thickened tissues as its distribution in the lung. Diffuse distribution does not give the same intensity of shadow to the radiological picture as does the nodular distribution. He suggests that the fibrosis of the lung tissue develops, in asbestosis, through the breaking down of the material of the asbestos fibres into SiO_2.

Italy.- According to the report of Loriga[34] to the International Conference on Silicosis held in Johannesburg in 1930, the study of pneumoconiosis has not been so extensive or profound in Italy as in certain other countries, especially the Anglo-Saxon countries. He considers this to be due to the fact that in Italy the composition of the minerals extracted or worked presents a relative poverty of siliceous material, and is not due to a limited number of workers engaged in dusty operations, or to hygienic conditions superior to those of other regions. Loriga states that information relative to hygienic conditions obtaining in the workers' homes and in the work places, and duration of exposure of the worker to the action of the dust, may play a preponderant role when the study of the disease has been completed by enquiry into the physical and environmental conditions. He mentions asbestos workers, slate, sulphur, and mercury miners as most exposed to injurious dust, but states that a true dust pneumoconiosis does not occur among marble workers.

Lovisetto[35] reported investigations of conditions of workers in the asbestos industry from 1902-1912 and from 1912 to the present with the following conclusions:

> In the second period extending from 1912 to the present time and following on the erection of a factory construction complying with

33 - Beintker, E., Die Asbestosis der Lungen: Arch. Gewerbepath. u. Gewerbehyg., vol. 2, Berlin, 1931, pp. 345-58. Quoted from Ind. Hygiene, vol. 6, p. 863, December, 1931.

34 - Loriga, Giovanni, Pneumoconiosis in Italy; Silicosis: Rec. Internat. Conf. Johannesburg, Aug., 13-27, 1930, pp. 481-504.

35 - Lovisetto, Domenico, Pulmonary Asbestosis: Rec. Internat. Conf. Johannesburg, Aug. 13-27, 1930, pp. 506-509.

the most hygienic modern precepts, conditions among the workers have greatly improved and further the workers were only engaged after selection by thorough medical examination. It must also be remembered that the periodical medical examination reveals at the outset the presence of morbid symptoms, even when these are still very slight.

In conclusion, inhalation of asbestos-dust in the long run causes pneumoconiosis; the period required for the manifestation of this pathological state is at least five years. There is a direct ratio between the quantity of dust inhaled and the pneumoconiosis; the higher the dust concentration the less time is necessary for the manifestation of fibrosis. It can reach complete development after a period of seven to nine years and it can cause death after 13 years on condition that the individual is continuously exposed to the risk in a very dusty atmosphere.

When the cause of the inhalation of the asbestos-dust is withdrawn the pneumoconiosis process is generally arrested.

The functional injuries caused by the inhalation of asbestos-dust occur very slowly and are characterised by dyspnoea on effort, and by a slight insufficiency of the right heart, the patient after being attacked may work for a long time with brief spells of rest.

It is very doubtful whether pulmonary asbestosis favours the occurrence of acute pulmonary affections though the anatomical conditions of the sclero-fibrous lung which cause a slowing down of the blood circulation in the lung (pulmonary stasis) may justify the supposition of a more ready development of the pathogenic germs in the respiratory passages.

Pulmonary asbestosis is a disease in itself which must not be confused with other diseases of the lungs; it is an occupational disease noninfectious and noncontagious. It is of slow progressive evolution, but when the irritant action of the asbestos dust inhaled has ceased the fibrous process is generally arrested.

Cases with a fatal issue are rare and at the present time, with modern means of protection, with highly perfected exhaust and ventilation apparatus they should no longer occur.

Pulmonary tuberculosis is on the other hand an infectious disease of slow progressive and quite characteristic evolution; and the anatomopathological data and pathogenesis are likewise typical.

It may be conceded that the inhalation of particles of asbestos, by causing chronic irritation of the respiratory passages of the lung, may favour in a limited number of cases, installation of the Koch bacillus.

According to Turano,[36] who examined 105 workers, the changes met with among Carrara marble workers may be classed in the initial stage of pneumoconiosis; that is to say, they comprise the least serious forms of the disease, such as the very marked reinforcement of the pulmonary outline, due as demonstrated by personal observations, to the processes of arteritis and lymphangitis, and in certain cases equally to conditions of emphysema usually present among those workers.

There have also been found frequent pleuritic changes which can be related to inhalation of marble-dust, but never, however, lesions of the pulmonary parenchyma. The radiological aspect of pulmonary tuberculosis among the workers examined is, on the other hand, highly important, since it shows an atypical picture on which are noted lesions with unusual sites and apical and subclavicular regions unaffected. It is this fact which has led to the admission of the probability of a combination of pneumoconiosis and tuberculosis.

Finally, statistical as well as radiological data justify, according to Turano, absolute exclusion of the theory of a particular benign or malignant course of tuberculosis among marble workers, as likewise of any kind of predisposition to the said specific disease.

Zanelli[37] describes the case of a workman employed in a pneumatic tire factory to inject powdered talc into the interior of the tires and to apply the same material to the outer surfaces of the tires by means of a cloth. During this work, the air contained a dense dust, but no masks were provided for the employes and no other means was adopted for their protection from the dust. The man developed grave digestive troubles, and X-ray examination of the lungs revealed the presence of the nodular formations typical of pneumoconiosis. Although talc has been regarded as a mineral forming a dust which only rarely has pathogenetic qualities, one of its properties seems to render it particularly dangerous. It forms extremely minute particles which do not irritate the sensitive nerve endings of the mucus on which they are deposited, so that such important means of defense as sneezing, coughing, and increased secretion are not brought into operation. In the case considered, indeed, the patient exhibited during work hours a weakening of the olfactory sense, the layer of dust on the mucus preventing the transmission of the olfactory stimuli to the nerve endings.

Netherlands.- The stonemasons act of 1911 and 1921, according to Kranenburg,[38] requires every stonemason under 21 years of age to have a stonemason's card, which is issued to him after a free medical examination, if the performance of this kind of work apparently will not be especially dangerous to his

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36 - Turano, Luigi, Radiological and Clinical Studies Effected Amongst the Carrara Marble Workers: Rec. Internat. Conf. Johannesburg, Aug. 13-27, 1930, pp. 509-511.

37 - Zanelli, Arturo, Pneumoconiosis Caused by Talc: Nature, vol. 127, London, May 16, 1931, Research Items, p. 759.

38 - Kranenburg, W. R. H., Silicosis in the Netherlands: Rec. Internat. Conf. Johannesburg, Aug. 13-27, 1930, pp. 512-534.

health. Adult stonemasons, those 21 years of age and over, must be examined; but a card is issued, irrespective of the results of the examination. A periodical examination of adult workmen takes place at the expiration of three years from the time the stonemason's card was issued. The first general examination of stonemasons took place in 1923, the second in 1926, and the third in 1929, so that it has been possible, although not in a large number of cases, to compare the clinico-physical condition of the lungs of the same person at the three dates with the three X-ray photographs. Kranenburg states that the results show that in nearly half the cases the X-ray examination gave more information than the physical examination. In a corresponding statement concerning 69 cases from the general examination in 1929, lung affections are not shown clinically in 19 cases, but are shown in the X-ray examination, and in 38 cases both clinically and by X-rays. He makes the following statement in regard to signs and symptoms:

> It is noticeable that in the general examination of stonemasons in 1923, 1926, and 1929, few complaints were received as to the state of health of the patients; most of them felt quite well, though a certain number complained of shortness of breath when moving. Here and there men complained of coughs with little or no sputum, which explains why altogether an examination of the sputum was made in only 48 cases, with positive results as to the presence of tubercle bacilli in 11 cases. After inhaling stone-dust for many years, complaint was made of irritation in the throat and a stifling feeling in the breast, with relative shortness of breath, an inclination to cough and expectoration, especially on rising in the morning. Generally speaking, percussive irregularities are few and auscultatory phenomena more striking: rough, heightened or weakened respiratory rustling, lengthened or jerky breathing in one or both apices or other places, also cracking and dry snoring noises, varying in strength and area, seldom damp or crapitating. Coughing and sputum which is not characteristic often only occur when bronchitis appears as a complication.
>
> The X-ray picture of pneumonoconiosis, due to the dust of various kinds of stone, does not differ in its various degrees from those given for silicosis by various investigators: (1) enlarged hilus-shadow, increased appearance of the retiform tissue and linear shadows; (2) increased appearance as in (1), and the appearance over a wide area of stippled shadows (mottling), and (3) appearance as in (2) and nodular shadows, large close mottling.
>
> The question of the mutual relations between pneumonoconiosis and tuberculosis, whether the tuberculosis only appears in later years as an infection on a foundation of silicosis--tuberculo-silicosis--or the silicosis is secondary to tuberculosis latent in youth and manifesting itself later--silico-tuberculosis--appears to be more and more answered in this sense, that each of the two processes favors the development of the other, and that the tubercle bacillus, appearing as a secondary factor, often seriously threatens health and life. In this connection the case is noteworthy of a stonecutter 47 years old who, on a clinical

and X-ray examination, showed an affection of the apex of the right lung without exhibiting radiologically any degree of silicosis after 34 years' work on sandstone.

Kranenburg's general conclusions are as follows:

The introduction and application of the stonemasons act has led to a clearer insight into the character of the "stonemasons' disease" and a more intelligent procedure in combating it by the improvement of the working conditions and personal hygiene of stonemasons.

The preliminary medical examination and annual re-examination of young stonemasons to a considerable extent prevents persons suffering from lung tuberculosis entering upon and continuing in stonemasons' work.

The periodical (three yearly) medical examination of adult stonemasons has shown the indispensability of X-ray examination for forming an opinion of lung affections.

The working of sandstone alone must be regarded as more injurious to the lungs than the working of limestone alone. The working of sandstone alone does not always lead to symptoms of silicosis and, on the other hand, the working of limestone alone (Belgian limestone, marble) does not prevent silicosis in a serious form. The working of sandstone and limestone alternately appears to produce less serious results in the same period than the working of sandstone alone.

Compulsory medical examination both in the form of preliminary examination and periodical re-examination should be introduced for sandblowers as well as for stonemasons.

Silicosis as an occupational disease of stonemasons should be assimilated to an accident for the purposes of the application of the accident act.

United States.- In studies on the effect of inhalation of asbestos-dust on tuberculous infection, Gardner and Cummings[39] demonstrated that fibrous structures at least as long as 200 microns can pass the protective mechanism of the upper respiratory tract and enter the lungs. Asbestosis bodies are not present in asbestos-dust previous to contact with animal tissues; they are produced by oxidation and hydrolysis of the chrysotile molecule.

In these studies it was found that asbestosis bodies, apparently identical with those described in the human being, have developed in guinea pigs after an exposure of approximately 70 days. In the rabbit these structures have not been discovered after exposures of as long as 330 days. In the albino rat

39 - Gardner, L. U., and Cummings, D. E., Studies on Experimental Pneumonokoniosis: VI. Inhalation of Asbestos Dust: Its Effect Upon Primary Tuberculous Infection (Concluded): Jour. Ind. Hygiene, vol. 13, No. 3, March, 1931, p. 111.

they are very rare. Only two small typical forms have been discovered in one animal exposed for 70 days. The prevalence of chronic infections of the lung in all members of this series is possibly responsible. It was found that primary tuberculous infection is influenced only to a limited degree by inhaled asbestos, but the combined action of asbestos-dust and tubercle bacilli in the lung produced more fibrosis than did either agent acting independently.

According to Boultman,[40] sand blasting is an occupational hazard due to the dusty, insanitary conditions that are unavoidable with the primitively designed equipment still being used at many plants. He divides the problem into four factors: (1) The abrasive, and facilities for keeping it clean and free of dust; (2) design and condition of equipment; (3) ventilating facilities for removing dust from the blasting chamber; and (4) protective equipment for the operator. He calls attention to the fact that the best silica sand offers little resistance to shattering and in many cases the dust from the shattered silica-sand abrasive exceeds the dust removed from the surface being blasted; the result is that the dust concentration in the sand-blast chamber is excessive, even with liberal ventilation, so that visibility is poor and production retarded. Steel abrasives themselves make no dust, they eliminate entirely all dust caused by the shattering of the abrasive, and thus eliminate 50 to 90 per cent of the dust created when silica sand is used. In regard to safety equipment, Boultman states that operators naturally look for convenience and, mainly through ignorance of consequences, disregard the merit of equipment which provides the best protection. The employer knows the relative merits of the various kinds of protective equipment, and therefore, as he is in a better position to select the proper protection, he should decide on the equipment and insist upon its use.

In an article on the chemical-engineering control of industrial lead poisoning, Safety Engineering[41] states that the skill and experience of industrial physicians are highly important essentials in the prevention and control of lead poisoning, as medical knowledge is invaluable in the detection of the early symptoms of lead absorption and as the physician is the only one who can prescribe suitable treatment for leaded employees and administer it with the best possible results. It is also within the province of the physician to make a study of the plant, to classify the operations and working locations according to the severity of the exposure, and to arrange for the transfer of affected employees to lead-free areas. The article also points out that engineering control of lead poisoning does not stop with the correction of physical exposure, the provision of safety devices, or the establishment of welfare and hygienic aids. Over and above all, a definite and proper mental condition must be created which will cause executives and supervisors to

40 - Boultman, Charles, Dust Prevention and Suppression in Sand Blasting: Address before the Fourth All-Ohio Safety Congress and Exhibit, Columbus, Ohio, April 22, 1931.

41 - Safety Engineering, The Chemical-Engineering Control of Industrial Lead Poisoning: vol. 62, No. 2, Aug., 1931, pp. 104-109.

realize the importance of preventive measures - that they are part and parcel of the productive program. Moreover, the employees must be so educated that they will be convinced that lead absorption or poisoning is wholly avoidable and unnecessary, and that compliance with mandatory orders and plant instructions is for their personal benefit because it will increase their welfare and efficiency. In conclusion the article states that the chief essentials for success in controlling lead poisoning or lead absorption are the close coordination of the plant physician and the engineer, and sincere company-executive participation in the execution of any program of control that may be developed. Good physical conditions, sanitary surroundings, proper medical service, and skilled engineering supervision can attain the sought-for objective.

Washington University, in cooperation with the Research Laboratory of the American Society of Heating and Ventilating Engineers,[42] is undertaking the development of a more sensitive and accurate method of determining air dustiness. This work has been under way during the past year and gives promise of very valuable developments.

The Technical Advisory Committee on this subject has been actively engaged in developing a program for future activity. Its plans include the development of a code for testing air-cleaning devices, but since no instrument now on the market is entirely satisfactory for all purposes, it is proposed by the committee to cover by specifications the design of an instrument of a jet-impingement type for industrial and field work, and of an instrument of the filter type for investigation of atmospheric pollution. The committee hopes to correlate the various interests and activities in the field of atmospheric dust and smoke study.

Pancoast and Pendergrass[43] give the following conclusions from their review of pneumoconiosis:

1. The subject of pneumoconiosis has been reviewed from the standpoint of its etiology, its pathology, and its roentgenographic appearances.

2. Pneumoconiosis is a more or less necessary risk of commercial development in the progress of civilization, but its progress and serious aspects may be lessened by certain preventive measures in most instances. Its incidence in many industries apparently can not be altogether eliminated.

3. It has aroused widespread interest and has received a great amount of study during the past few years.

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42 - Heating, Piping and Air Conditioning, Atmospheric Dust and Air Cleaning Devices (Report of the American Society of Heating and Ventilating Engineers Research Laboratory, June 1, 1931): Aug., 1931, pp. 702-703.

43 - Pancoast, H. K., and Pendergrass, E. P., A Review of Pneumoconiosis; Further Roentgenological and Pathological Studies; Reprinted from Am. Jour. Roentgenol. and Radium Therapy, vol. 26, No. 4, Oct., 1931, pp. 556-614.

4. The roentgenological examination is the most important and accurate means of detecting its presence, especially in early cases, of studying its progress and of determining its extent and severity. Rapidity of progression is easily determined by serial study.

5. Roentgenology will be employed more and more extensively as the necessity of study of workers in hazardous industries becomes realized and regulations for protection and compensation laws are adopted in this country. The roentgenologist must be experienced in his work and honest in the expression of his opinions.

6. It behooves the roentgenologist to become thoroughly familiar with the subject from every angle. The particular hazards of certain industries must be understood and the roentgenographic appearances more or less characteristic of some of them must be learned.

7. Roentgenographic appearances are the expressions of pathological changes, and to properly interpret them requires an intimate knowledge of the pathology of the condition. A resume is given of the present exact knowledge of the pathology of pneumoconiosis based upon autopsy study and animal experimentation. Various theories advanced in explanation of some uncertain points are given brief consideration.

8. Various classifications of the degrees of progress of the condition are in use in different countries. Most of these have a clinical basis with which roentgenographic appearances must be made to conform. No one of them seems adequate or entirely satisfactory in its application to every dusty industry, especially from the standpoint of the roentgenologist. A new pathological-roentgenological classification is proposed, or at least offered as a suggestion.

These authors state that they seem to have authority for two actions of coal-dust - it retards the action of silica when there is a slow intake of the latter, and it enhances its action when the intake of silica is rapid. In regard to the alleged protection directly or indirectly afforded by coal-dust against tuberculosis they make the following statement:

If there is any protection in the industry, it probably arises from other factors. The important ones, at least in one district, are well embodied in an old paper by Wainwright and Nichols, in 1905. In seeking a cause for the supposed protection against tuberculosis in the anthracite regions of Pennsylvania, they finally concluded that it was an actual fact, probably due to several factors. As contributing ones they suggested the following: The absence of crowding at work; lack of extreme overcrowding in housing; the custom of these miners in walking or riding considerable distances; the forced daily bath because of the black dust accumulated on the body each day; the moisture of the mines preventing sputum from drying and the gradual bacterial purification of the air from mine entrances to the working chambers. Animal

experimentation suggested that the coal-dust offered some protecting influence against tuberculosis through the stimulation of a mild fibrosis, which they thought was the essential factor, but coal-dust had no direct bactericidal action.

Meriwether and Sayers[44] call attention to the difficulties in diagnosis of the early stages of silicosis, as the development of the disease may extend over a period of years and be so gradual that the early symptoms are often not recognized by those so afflicted or are considered to be such a slight departure from the normal that they are not important. As the disease progresses, the clinical symptoms become more definite, and those afflicted recognize that there exists some condition which interferes with normal working efficiency. With further progress of the disease, the working efficiency becomes so markedly affected that there is in many cases total disability. In this stage there is a definite tendency to develop complications, particularly tuberculosis or infective silicosis. The slow progress in the development of the disease has caused observers in this country and abroad to divide the disease into three stages - first, second, and third. In regard to the use of the X-ray in diagnosis, the statement is made that the value of the X-ray method of diagnosis is largely dependent upon the skill of the technician making the pictures and the experience of the reader in interpreting them. With efficient technic in the operation of the X-ray machine and with a fair amount of clinical experience, the physician can make a definite diagnosis of silicosis by the X-ray alone and can distinguish it from other chest pathology with reasonable certainty. The treatment recommended for silicosis is preventive and curative. The prevention treatment lies entirely in protecting the workers from exposure to unduly large amounts of dust and in giving a yearly physical examination in order that they can be warned on the first evidence of silicosis to change their occupation to a nondusty one. In the early stages the curative treatment is to remove them from the dusty occupation, and in the later stages symptomatic treatment gives some relief.

In a study to determine the percentage of dust or fume retained at concentrations of less than 50 milligramsper cubic meter, the following results are reported by Brown:[45]

> Four hundred and twenty-two experiments on the retention of magnesium oxide fume and of calcium carbonate (marble) dust by 32 subjects breathing normally while at rest, through the mouth while resting, and normally during exercise and during the inhalation of approximately 5 per cent carbon dioxide in the air gave the following results:

44 - Meriwether, F. V., and Sayers, R. R., Silicosis: Jour. Oklahoma State Med. Assoc., vol. 24, Oct., 1931, pp. 317-324.

45 - Brown, C. E., Quantitative Measurements of the Inhalation, Retention, and Exhalation of Dusts and Fumes by Man; II. Concentrations Below 50 Mg. Per Cubic Meter: Jour. Ind. Hygiene, vol. 13, Oct., 1931, pp, 285-291.

The percentage of magnesium oxide retained during normal breathing while at rest varied from about 60 per cent at a concentration of 10 milligrams per cubic meter to 45 per cent at 50 milligrams per cubic meter. The percentage of calcium carbonate retained under the same breathing conditions varied from about 80 per cent at 10 milligrams per cubic meter to 70 per cent at 50 milligrams per cubic meter.

The percentage retention for mouth breathing while at rest and for normal breathing during exercise and during carbon dioxide inhalation was about 10 per cent less than for normal breathing while at rest under the same conditions.

The percentage retention changed but little at concentrations above 50 milligrams per cubic meter, but apparently rapidly approached 100 per cent as the concentrations fell below 10 milligrams per cubic meter.

A further study[46] of the above data, to explain the differences noted and to determine some of the factors that influence the retention of inhaled dusts and fumes, gave the following results:

Analysis of the data obtained from 418 dust-retention experiments using magnesium oxide in 363 and calcium carbonate in 55, and employing 32 subjects breathing normally, shows that percentage retention varies with certain measurable factors:

1. Percentage retention is inversely proportional to respiration rate for rates below 20 per minute. An increase above 20 per minute is apparently followed by no change in percentage retention.

2. Percentage retention is inversely proportional to minute-volume of air breathed. This effect probably results from the increase in respiration rate with minute-volume.

3. Percentage retention is directly proportional to particulate size (not particle size) and to density of dust suspended in air.

4. Percentage retention is directly proportional to extent to which the dust is wetted in passing through water.

The results also show that percentage retention apparently is not affected by the following factors:

1. Volume per respiration.
2. Vital capacity.
3. Relative humidity of inspired air.

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46 - Brown, C. E., Studies in Dust Retention; III, Factors Involved in the Retention of Inhaled Dusts and Fumes by Man: Reprinted from Jour. Ind. Hygiene, vol. 13, No. 9, Nov., 1931, pp. 293-313.

Published data on dust retention obtained by other investigators are summarized, but owing to the lack of essential information it is not possible to compare the results with those obtained in the present study. A chart summarizing the data on magnesium oxide and calcium carbonate is presented as a graphic aid in estimating dust retention by man.

In an article on the dusts encountered by the heating, piping, and air conditioning engineer, Spafford[47] calls attention to the "intimate association" of dust with our lives. He discusses why the engineer should know what dust is, where it is, the kinds of particular concern to the engineer, and so on. He discusses "the kinds of dust with which the engineer is concerned" as follows:

> But the dusts with which heating, piping and air conditioning engineers are most concerned form but a small part of this great kingdom of dust. They are the dusts that are detectable by man. They are those which we think may have some readily observable effect upon health and comfort, which will help or hinder in manufacturing, which must be conserved because of their value, which must be removed because they are obnoxious, which must be separated as to their size in order to improve quality or maintain the standard of a product, or which must be conveyed.
>
> The largest particle of dust in this field of what we might term physiological and obnoxious dusts probably would be 72 times the diameter of the smallest particle. They might range from 1/25,000 of an inch to 72/25,000 of an inch with average dust particles 3/25,000 to 4/25,000 of an inch in size. Dust particles, however, are usually measured in microns. A micron is 1/1,000 of a millimeter or approximately 1/25,000 of an inch.
>
> In that province of the kingdom of dust known as obnoxious, objectionable, or unhealthful dust there may be grains of pollen, bits of vegetable fiber, hairs, carbon, particles of earth, ashes, particles of horseshoes and harnesses as well as automobile tires worn off on the cobble stones and pavements, threads of cotton, coal dust, shreds of wool or silk, animal excreta, smoke, water-dust, clay, stone, and materials of infinite variety and often riding on these particles are bacteria, fungi, and other living germs some harmful or beneficial or indispensable to human beings and animals; some harmless, some harmful, some beneficial or even necessary in manufacturing.
>
> One classification of dust might be as follows: Dusts from outdoors which are removed from buildings because of their effect upon human beings or animals (these have been mentioned heretofore); and manufacturing dusts; these may be marble-dust, granite-dust, mercury-dust, fumes from smelting ores, wood-dust from sanding machines and other wood

47 - Spafford, L. B., A Review of Dust: Heating, Piping and Air Conditioning, Jan., 1932, pp. 34-35.

operations, silica-dust, zinc oxide, fumes from plating baths, dusts from brass foundries, magnesium oxide, aluminum, chromium, iron and other oxides, particles and pigments and oils from spray painting, metals from grinding or buffing machines, fly ash, calcium-dust in a Portland cement plant, silica-dust in granite-cutting plants, carbon-dust in coal mines, vegetable-dust in a cotton manufacturing plant, and metal and other dusts in a silver polishing plant.

Some of the dusts that are the foundation of manufactured products or are usable in dust form are: Portland cement, pyroxlyn powder, bakelite powder, rubber, silica, charcoal, granulated slate, powdered coal, bone ash, soap powder, insecticides, volcanic ash, grains such as wheat, oats, rye, barley, and corn, synthetic coffee, talcum powder, toilet powder, gypsum, paints, dyes, kitchen cleanser, tungsten, litharge, wood flour, chicken feed, powdered milk, and so forth.

Clark[48] analyzed the hazard present from the use of artificial abrasives at a large grinding-wheel company, and makes the following report of a third study to review the amount of pulmonary tuberculosis that has developed in this plant during the past 13 years:

> The crystalline dust present in the workrooms is composed of aluminum oxide and silicon carbide. Careful attention to dust removal has been given where the hazard is present. No dust counts have been made. The exhaust pipes extract dust from the point at which it is produced, at a rate exceeding the stipulated 1,500 linear feet per minute wherever it is possible. There are some departments where the fineness of the product makes the engineering problem of dust removal extremely difficult, and in these departments there is a considerable amount of dust in the air.
>
> In the plant under consideration, from Jan. 1, 1918 to Dec. 31, 1930, there have been 42 cases of active pulmonary tuberculosis, 38 of which have occurred among men and 4 among women. Of the group, 37 were employed at factory work of some kind, while 5 did only clerical work.
>
> Of the 42 workers who developed tuberculosis, 20 are dead, 18 are living, and 4 can not be traced. Of the 18 living, 13 are now working, 3 are at home under care of a physician, and 2 are in hospitals. The average number of employees during the period (13 years) has been 2,460.
>
> Of the cases of active pulmonary tuberculosis developing during the period, 13 occurred among workers in departments where artificial abrasive dust was present in large quantities, and 2 occurred among those working in clay which contains 9 per cent of free silica. Twenty-two worked in departments such as the machine shop, packing rooms, etc., in which there was no dust hazard, and five were office clerks who had no contact with dust.

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48 - Clark, W. I., The Dust Hazard in the Abrasive Industry; Third Study: Jour. Ind. Hygiene, vol. 13, Dec., 1931, pp. 343-346.

Of those who developed active pulmonary tuberculosis in the departments where abrasive dust was prevalent, 3 developed symptoms in less than one year, 6 in less than four years, 1 in five years, 1 in 15, 1 in 20, and 1 in 21 years. Four of these developed the disease immediately following an attack of influenza and after very short exposure to dust. Of those working in clay-dust, one developed the disease after 12 years and one after 36 years service.

Among those working in abrasive dust departments, in proportion to the number of workers involved there were approximately twice as many cases of pulmonary tuberculosis as among those in the departments where no abrasive dust occurred. It was stated that in four of the cases in abrasive dust departments the pulmonary tuberculosis developed immediately following an acute attack of influenza. If these cases are omitted, the number which might be attributed to dust excitation of a latent process is reduced to nine, or a proportion of one and one-half times as many cases as occurred among those working in departments where there was no abrasive dust hazard.

About the only conclusion which can be drawn from the present study is that it is inadvisable for persons who have had pulmonary tuberculosis to work in a department in which large amounts of artificial abrasive or any other dust are present.

An experience of 13 years in the experimental study of pneumoconiosis has convinced Gardner[49] that the disease silicosis can be reproduced in guinea pigs and rabbits by prolonged inhalation of quartz-dust. Its production follows the daily inhalation of sufficient quantities of finely divided silica over a period of many months or years. According to Gardner,

In the initial stages of the disease, phagocytes are more active than usual, perhaps because they are irritated by the ingested particles. They play a leading rôle in transporting the dust to points where intimate contact is established with connective tissue cells. These elements are in turn stimulated, undergo active proliferation, and develop a most extensive reticulum network. After a year has passed, degenerative changes appear in the newly formed cells with peculiar changes in the reticulum. Many of the cells degenerate, leaving a collection of coarse hyaline fibers with occasional compressed nuclei. In the rabbit, calcification is a common sequela. The degeneration is a local manifestation of the toxicity of quartz dust and not an effect of ischemia. Other toxic effects are exhibited in the rapid death of phagocytes and in the follicles of lymph nodes involved in the process. There is no evidence that poisonous substances circulate in the blood to damage the kidney and other organs.

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49 - Gardner, L. U., Studies on Experimental Pneumonokoniosis. VIII. Inhalation of Quartz Dust: Jour. Ind. Hygiene. vol. 14, Jan., 1932, pp. 18-37.

Silicosis is a progressive process when once a sufficient quantity of quartz has been inhaled.

In the development of the disease the tracheobronchial lymph nodes are first extensively damaged and largely replaced by characteristic nodular fibrosis. This interrupts the normal flow of lymph from the lungs and produces inflammatory thickening along the course of the afferent lymph vessels within the lung. Nodular lesions already started progress more rapidly within the intrapulmonary lymphoid tissues. When these structures have sufficiently enlarged, a further interference with the eliminating apparatus results and dust is implanted in increasing quantities in the alveolar walls. A "fine fibrosis" in the parenchyma of the lung is produced. In the guinea pig similar changes are brought about in the liver by dust carried to it through the blood stream. As long as its lymphatic circulation is competent, no significant reaction occurs within the organ. When its appropriate node has been obstructed, the hepatic nodules develop.

Comparative studies with other dusts have thus far indicated that only silica and the silicates are capable of exciting significant reactions in the connective tissues of the lungs. Marble, soft coal, and carborundum dusts have produced no fibrosis within periods of four years. Granite-dust acts very slowly and only in the tracheobronchial lymph nodes has it caused the formation of typical nodular fibrosis. Asbestos-dust forms collars of fibrosis about the respiratory bronchioles and proximal alveolar ducts in which it comes to rest, perhaps because of its fibrous structure.

These observations have suggested the general hypothesis that siliceous dusts excite reaction in so far as they are able to establish direct contact with connective tissues. Such contact is determined by the reaction of the phagocytes to various types of dust.

According to Kessler,[50] recently in New Jersey over 100 cases of silicosis are alleged to have occurred in the abrasive powder industry, involving four companies which pumped up sand by hydraulic pressure to a plant where it was washed, steam dried, screened into various sizes and then pulverized in closed tubè mills. The free silica content of the completed product was approximately 99.24 per cent, and of the order of 1 to 5 microns in size.

While most of the claimants were employed at or near the packing operation, others were in the wet processes, and several women were in the bag-cleaning work. Six persons have died and have been autopsied by Dr. Martland of Newark. Many others have been reported to have died, but the results of the autopsies in these cases are not known. Of 40 X-rays of cases reviewed by the author, only four could be called ante-primary, although some others showed varying degrees of fibrosis without characteristic mottling.

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50 - Kessler, H. H., Silicosis in the Abrasive Powder Industry: Am. Jour. Public Health, vol. 21, Dec., 1931, pp. 1390-1392.

The most outstanding feature of these cases has been the allegedly short exposure period--apparently as brief as four months to one and a half years. Others have had an exposure of as long as six years. Many of the cases have been seen by competent observers and studied by Roentgen rays and reported as first or second stage silicosis.

South Africa.- Few reports of work done in South Africa seem to have been issued since the extensive summary of the entire subject presented at the silicosis conference in Johannesburg in 1930.

Simpson and Strachan[51] report the following results from an examination of the sputum of 50 workers in an asbestos mill, some of whom also had been exposed to asbestos-dust elsewhere:

> The inhalation of asbestos-dust in high concentrations leads to the appearance of asbestosis bodies in the sputum in a large percentage of the workers exposed thereto. They were present in 48 out of 50 workers examined.
>
> Asbestosis bodies were as easily demonstrated by direct thick films as by the antiformin method.
>
> The sputum was always mucoid in character when there were no bronchial complications. It may resemble egg albumen. In none of the sputa were tubercle bacilli demonstrated.
>
> Study of the intracellular asbestosis bodies in these cases suggests that they are formed by the deposition on the asbestos fibre of an iron-containing substance elaborated by the cell.

SUMMARY OF RECENT LITERATURE ON EFFECTS ON WORKERS OF EXPOSURE TO TOXIC OR NOXIOUS GASES

In an analysis of some 270 fatal accidents due to fire damp that have occurred in Great Britain, Germany, France, and Belgium since 1928, Audibert and Delmas[52] list 37 cases of asphyxiation by fire damp.

The authors point out that although the widespread adoption of portable electric lamps tends on the whole to eliminate the dangers of fire damp ignition, it may be expected to increase the number of cases of asphyxiation. On the other hand, the relative danger, as well as the scale of mortality, is much less; again, the peril is one that can be combatted quite easily without abating the use of the electric lamp. It is significant, indeed, that in

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51 - Simpson, W. F., and Strachan, A. S., Asbestosis Bodies in the Sputum. A Study of Specimens from Fifty Workers in an Asbestos Mill: Jour. Path. and Bact., vol. 34, No. 1, Jan., 1931, pp. 1-4.

52 - The Colliery Guardian, Editorial: Vol. 140, London, Oct. 30, 1931, pp. 1478-1479.

Germany there was only one case of asphyxiation in the two years 1927 and 1928, notwithstanding that the 332,930 electric lamps in use on January 1, 1927, constituted no less than 90 per cent of the total number of lamps in use. Sixteen of the 37 accidents in this class occurred in Great Britain, but the authors confess that they are not so well acquainted with the details of these as with the 21 accidents that occurred in the same period in Germany, France, and Belgium. These accidents may be subdivided as follows: (1) Sudden outbursts of fire damp, sometimes accompanied by a fall, temporarily rendering the air in a stall incapable of supporting life; (2) cases where the worker penetrates into an abandoned and unventilated portion of the workings; and (3) asphyxiation occurring in a normal accessible working place through lack of ventilation. Of the 21 accidents, 4 were of the first type, 8 of the second, and 9 of the third. Each of these accidents is separately analyzed, and the authors think it very doubtful whether any of the first type could have been avoided by prescribing the use of flame lamps, as the warning given by the latter would not have sufficed to allow the workmen time to escape in the highly inclined working places where they occurred, and as the speed of exit depends materially upon the possession of good lighting. The logical remedy, according to Audibert and Delmas, is to use a fire damp indicator or flame safety lamp in conjunction with the electric lamps. It is essential, however, that the workmen should be capable of reading the warnings given by such appliances and of acting upon them without a moment's delay. In England much the same view is held; the defect of the system advocated is that the flame lamp is too often neglected when it is not used as a means of illumination. The matter is largely a question of training and discipline, and to this fact may be attributed the immunity from this class of accident in Germany. The danger, it may be added, is still more pronounced in any system of lighting from the mains, owing to the greater liability that the whole of the lights may be extinguished. The use of electric lamps, Audibert and Delmas consider, may tend to increase the prevalence of accidents of the second type referred to, and one case is mentioned where the workman had actually left his flame lamp behind before entering the old workings, presumably because he suspected that it would be extinguished! The best remedy against such foolishness is to render access to such places impossible. Such measures the authors regard as a necessary corollary to the generalized use of electric lamps. The third type of accident is that which appears a priori to be most likely to increase with the suppression of flame lamps, yet of the nine accidents dealt with there was one only in which the workman did not carry a flame lamp; in the others the victims had neglected to test for gas or had ignored the indications; when both kinds of lamp were in use, extinction of the flame was disregarded. This also points to the need for greater discipline and the cultivation of a better respect for danger; but it is necessary also to blame the management, which is responsible for the defective ventilation.

Canada.- According to Nicholson[53] a dashboard dial has been devised that indicates the percentage of carbon monoxide in the exhaust gas of automobiles. He discusses the device as follows:

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53 - Nicholson, D., Carbon Monoxide Poisoning: Canadian Pub. Health Jour., vol. 22, No. 12, Dec., 1931, p. 606.

It depends on the fact that the electric resistance of platinum wires increases as they become heated, and this shunts the current through a meter which indicates the amount of carbon monoxide pouring out of the exhaust. The platinum is specially treated to act in the same manner as the sponge platinum used for the type of gas lighter which begins to glow when held over a gas jet. There is a pipe lighter which works on the same principle. Let us hope that this device will be perfected in the near future and become standard equipment on all cars. It will not abolish monoxide from the exhaust gas but it is a splendid warning. There is another reason why this meter will attract much attention. It tells the percentage of fuel wasted and so will make for economy by enabling the operator to cut down on mixtures that are too rich.

The effects on health of smoke and fumes in the atmosphere in and around industrial centers continues to claim the attention of public health officers, as well as the general public affected.

<u>Belgium</u>.- A number of conjectures have been made in regard to the cause of the catastrophe that occurred in the Valley of the Meuse in December, 1930, when hundreds of persons became ill and 63 died. Van Leeuwen[54] gives the following description of this untoward event:

On December 1, a Monday, a fog developed in Belgium and in the Netherlands. In the valley of the Meuse the fog was especially heavy, and on account of an absolute calm it did not lift until Thursday afternoon. On Friday it again became foggy and it remained so until Sunday. On Tuesday and Wednesday the fog was especially heavy. On Wednesday a large number of persons complained of irritations in the nose, mouth, throat, trachea and bronchi. The mucous membranes were red and swollen. Necropsies later revealed that the inflammation reached down into the large ramifications of the bronchi. The patients coughed and the respiration frequency was more than 40 a minute. In the serious cases dyspnea, dilatation of the heart, high pulse frequency and cyanosis developed. Signs of pneumonia were not present. Injections of epinephrine brought temporary improvement, and cardiac stimulants were also administered. Among those who were seriously ill, and especially among those who died, there were many old persons, also persons with asthma, bronchitis and heart disease. However, it was also noted that young persons who had been healthy before became seriously ill and that many others felt an unpleasant irritation in the throat. The 63 fatalities all occurred within 24 hours and in the narrow valley south of Liege. In discussing the causes of the catastrophe the author points out that the opinion that the heavy, cold fog is irrespirable and that the fatalities were due to suffocation from lack of oxygen is not tenable because heavy, cold fogs are quite frequent on the sea coast of the Netherlands, and yet there are no fatalities. The theories of war gases and of Sahara

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54 - van Leeuwen, Storm, Fog Catastrophe in Industrial Section South of Liege: Jour. Am. Med. Assoc., vol. 96, No. 16, April 18, 1931, p. 1347.

sands are likewise dismissed. In traveling through this region the author noted numerous factories such as zinc industries, superphosphate factories and other industrial plants. It may be assumed that even under normal conditions the air contains irritative substances such as sulphur dioxide and hydrofluoric acid. It is also known that this region is fit for neither agriculture nor cattle raising. That this is due to the presence of the factories is proved by the fact that the cattle raisers had a lawsuit against the manufacturers and were paid damages. The cold and heavy fog and the absolute calmness during the first days of December prevented ventilation, and it is also possible that some of the factories discharged an abnormally large amount of poisonous substances during these days. This catastrophe teaches that the harmfulness of gases discharged by certain industries should not be estimated on an ordinary day but on the concentrating effects of fogs should be taken into consideration.

England.- Des Voeux, president of the National Smoke Abatement Society, in his annual address[55] said that excessive smoke was not a necessity, but a luxury of laziness, which should not be allowed by authorities charged with the protection of the health of the people. The local authorities were working in conjunction with the Department of Scientific and Industrial Research, which was investigating the impurities of the atmosphere. In a square mile of the city of London, 150 tons of dirt fell in 1911, while in 1930 the figure was 380 tons. Similar figures were obtainable from other large centers. The destructive elements in the combustion of coal was now known to be sulphur dioxide, which was turned into sulphuric acid in the air. The report on the disastrous fogs in the Meuse Valley last winter stated definitely that the deaths were due to suffocation, which might easily be reproduced in closely inhabited neighborhoods had not the Government been forewarned in time to insist that measures be taken to prevent the escape of this gas into the air, or to neutralize it before it escaped. At the new electric station being erected at Battersea (in London) the enormous amount of 2,000 tons of coal would be burned daily, emitting, at the smallest calculation, 30 tons of sulphur, which is equivalent to 90 tons of sulphuric acid. Imagine the effect of this acid, if it should accumulate for four or five days, as it well might, on the unfortunate population of closely packed Battersea. But in speaking of factory smoke, Des Voeux did not minimize the effect of the domestic chimney, especially the kitchen range. However, the domestic chimney could not be abolished until smokeless fuel could be produced at the price that the poor could afford.

A report was presented by the Greater London Joint Smoke Abatement Committee, regretting that no satisfactory method of measuring the density of smoke had yet been evolved. The subject was still receiving the attention of the Government fuel research station. Great progress had been made in London in connection with the control of smoke emission. Beneficial effects were being secured under the law which prohibited the emission of black smoke for

55 - des Voeux, H. A., Air Pollution by Smoke, (Foreign letter): Jour. Am. Med. Assoc., vol. 97, No. 18, Oct. 31, 1931, p. 1313.

more than three minutes in 30, but the committee was still not satisfied and regarded a 2-minute period as necessary, which it hoped would be in force in 1936.

The Department of Scientific and Industrial Research,[56] which is responsible for the investigation of atmospheric pollution, has exhibited at its conference with the local authorities, who collaborate with it, some new devices for measuring air pollution. The apparatus commonly used is the standard deposit gage. Material deposited from the air into the funnel of the gage is washed by rain into a bottle beneath, and at the end of every month the contents are analyzed. The method gives some idea of the amount of sulphuric acid in the atmosphere, the most destructive element of air pollution, but it does not provide an estimate from day to day. This can now be gained from an apparatus developed by the Government chemist, which will be used to determine whether a great new power station in course of erection in London is emitting sulphur fumes. The air to be examined is pumped through a glass tube containing a chemical that absorbs sulphur dioxide and fixes it as sulphuric acid. Several local authorities have adopted an automatic air filter devised by J. S. Owns, the superintendent of observations, to measure the amount of suspended impurity in the air. A standard volume of air is passed through filter paper, forming on it a dark spot of varying blackness according to the amount of impurity. By a clockwork arrangement, records corresponding to each hour of the day are obtained; the degree of blackness of each series of spots is afterward measured by comparison with a standardized scale of shades numbered from 1 to 20.

Another new apparatus is for measuring daylight. The light passes through an optical wedge, in contact with which is a metal plate perforated with small holes in a line. The light transmitted through these holes varies in intensity from one end of the line to the other. By means of a split lens, two images of the holes are formed on photographic paper, and by light filters the radiation forming one image is confined to the ultraviolet region, the radiation forming the other to a portion of the visible spectrum. The photographic record for the day, therefore, consists of two parallel rows of dots, each diminishing in shade along the row. By noting the last hole visible in each line, an arbitrary measure of the relative average intensity of the two kinds of radiation is obtained and the variations in the total amount of daylight from day to day can be estimated. Seven such records can be taken, one for each day of the week, before the sheet of photographic paper is changed and the clockwork rewound.

The Lancet[57] mentions the case of a man who, after becoming apparently perfectly acclimatized to a low partial pressure of oxygen, had his chest movements restricted by a bruising of the thorax. As a result he suffered

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56 Journal of American Medical Association, Foreign Letters, London: Vol. 96, No. 23, June 6, 1931, p. 1963.
57 The Lancet, vol. 11, No. 43, London, Sept. 26, 1931, p. 683.

from anoxaemia and developed symptoms usually associated with a sudden reduction of the partial pressure of oxygen in an unacclimatized person. The margin of safety is low. Pneumonia at high altitudes is for the same reason rapidly fatal, the condition of the patient being similar to that of a pneumonic patient at low altitudes whose oxygen demands are suddenly increased by movement.

Greene,[58] in an attempt to sum up the present position in regard to the use of oxygen in climbing Mt. Everest, states that the recent success of the British Himalayan Expedition in climbing, without the use of oxygen, 10 of the greater Himalayan peaks, including Kamet (25,447 feet), the highest summit yet attained, has brought once more into prominence the question of the use of oxygen on Everest. It is a question on which both climbers and physiologists are divided.

> The problem to be solved is whether or not oxygen can be regarded as a helpful factor in high climbing. One school of thought claims that, in the face of theoretical considerations and practical experience, it is impossible to deny its usefulness. The special difficulties of Everest are due chiefly not to terrain or climate but the want of oxygen. To supply this want can scarcely fail to reduce the difficulties of the ascent. Moreover, Prof. J. Barcroft has shown by direct experiment that, under laboratory conditions, it is possible to do by means of oxygen what is certainly impossible without it--to climb at a rate of a thousand feet an hour, without previous acclimatisation, at a barometric pressure equal to that of the summit of Everest. Much practical experience points in the same direction.
>
> The no-oxygen school claims, on the other hand, that the conclusions are unsound because, both in the Barcroft steel chamber experiment and on Everest, the 'subjects' were either unacclimatised or only partially acclimatised. Acclimatisation appears to occur in three different ways. In the well-trained person, oxygen secretion by the lung epithelium increases the oxygen supply to the blood at a very early stage of an ascent. The existence of oxygen secretion is denied by some physiologists. In this battle of the giants I do not propose to take a part. It does not affect our main issue, because it does not occur to a sufficient extent to affect the question of whether or not oxygen should be carried on Everest. A great increase in the haemoglobin percentage of the blood undoubtedly occurs, but this increase will not make possible the continuance of life at very great altitudes, unless supported by an actual increase in the pressure of oxygen in the lung alveoli. This increase is attained by deep breathing.

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58 Greene, Raymond, Oxygen and Everest: Nature, vol. 128, Nov. 28, 1931, pp. 893-894.

If, then, the oxygen school believes in the usefulness of oxygen for high climbers, whether acclimatised or not, and the no-oxygen school believes in its usefulness for the unacclimatised, a method of attack in conformity with both points of view appears at first sight to be obvious. It should be possible to eliminate the necessity for acclimatisation by using oxygen from a low level on the mountain and climbing it at alpine speed. But here two great problems present themselves. It is very difficult to construct an apparatus which will without waste deliver the required quantity of oxygen while the climber is eating and sleeping; and it is impossible at the moment to find an apparatus which can be trusted never to go wrong. The failure of his oxygen apparatus near the top of Everest would mean death to the unacclimatised mountaineer.

The other extreme view has also been presented, but never by anyone with experience of Himalayan climbing--the view that Everest should be attacked by a party prepared, if necessary, to spend a year upon the mountain. To rush a mountain is folly, unsound in theory and disastrous in practice. Siege tactics have been proved sound. But there must be moderation even in slowness. The weather of the great peaks allows only a limited time in which to make the ascent, and many months upon a mountain undermine the health of the climbing party. It is possible that before sufficient acclimatisation for an oxygenless assault on the summit of Everest has been attained, altitude deterioration may have set in. If by relying on oxygen for the last few thousand feet of Everest it is possible to reduce the time on the mountain and thus the danger of deterioration, the chances of a successful attempt will be increased. Whether this can be done will be determined by direct experiment in a steel decompression chamber.

The practical difficulties of oxygen are serious. The apparatus in use in 1924 was so heavy that, in the opinion of some, its weight outbalanced its advantages. Valves tend to freeze or leak, and complicated taps are difficult to work under trying conditions. Many improvements have been made in the last five years, but there is room for more. There should be produced a light, simple, and efficient apparatus, thoroughly tested in refrigerators and mid-tunnels and on the mountains of Europe. This task has been undertaken by a committee of the British Association. If such an apparatus can be designed it should, as soon as permission can be obtained, be placed in the hands of a young, well-drilled, and well-organised party. Such a party will, in my opinion, climb Everest. It will at any rate show us whether or not oxygen can be of service to the unacclimatised man.

The investigations by Bancroft mentioned above were made in a steel chamber[59] wherein the barometric pressure was reduced to that at the top of Everest (11 inches of mercury). In the chamber, the exertions necessary for climbing 1,000 feet an hour were made by stepping on and off a block of wood 13 inches high. Although an ordinary person would faint in air at such low pressure, it was found that "the climb" could be done just as easily as outside at ordinary atmospheric pressure. Given the necessary oxygen, the drop of barometric pressure had no effect. Against this advantage there would be in mountain climbing such difficulties as the weight of the apparatus and the effect of frost on the valves and tubes.

In an article on the effect of carbon monoxide on small birds, Killick[60] mentions the following questions requiring investigation:

> (1) What is the lowest atmospheric concentration of carbon monoxide that will cause unmistakable symptoms in a bird? (2) Is this concentration sufficiently low to be harmless to man? (3) What conditions modify the reaction of the bird to carbon monoxide?
>
> To take these questions in order - as regards the first, a certain number of data have been collected by workers connected with the United States Bureau of Mines showing that a fresh canary will show unmistakable signs of distress when exposed to an atmosphere containing 0.16 per cent of carbon monoxide or more; possibly this figure should be put a little lower. The next question is, are concentrations of carbon monoxide below 0.16 per cent harmless to man? According to Haldane, in experiments performed upon himself, a percentage saturation of 35 to 40 in the blood is reached in an atmosphere containing 0.12 per cent carbon monoxide in two hours; in an atmosphere containing 0.21 per cent carbon monoxide in 45 min.; in an atmosphere containing 0.36 per cent carbon monoxide in 30 min. It appears, therefore, that canaries do not supply a perfectly safe indication of dangerous quantities of carbon monoxide, when these quantities are near the lower limit of danger.
>
> It has been noticed in experiments with canaries that birds show very considerable individual variation in their reaction to carbon monoxide; this variation becomes greater in degree with smaller quantities of carbon monoxide in the atmosphere breathed. In the first series of experiments all the birds were being exposed for the first time, and it is the birds exposed to 0.12 per cent carbon monoxide that show the biggest range of individual variation, while those exposed to 0.26 per cent carbon monoxide

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59 Journal of American Medical Association, Oxygen in Mountain Climbing: Vol. 97, No. 17, Oct. 24, 1931, p. 1236.

60 Killick, E. M., Effect of Carbon Monoxide on Small Birds: Colliery Guardian, March 6, 1931, p. 850.

show the smallest range. This question of individual variations is closely connected with that of adaptation to carbon monoxide. It is of considerable practical interest to ascertain whether the birds used to detect the presence of carbon monoxide undergo a process of adaptation similar to men, and a series of experiments was undertaken to throw light on this point. In every case, as a result of successive daily exposures to carbon monoxide the sensitivity of the birds to a test exposure progressively decreased. There is one exception to this, where at the end of one experiment the sensitivity increased again. There have been indications of this late result in other experiments, but the data are at present insufficient to warrant a discussion of its significance. Amongst the birds that did show distress, the time interval became greater with successive exposures. In one case, when exposed to 0.16 per cent carbon monoxide, the birds ceased to show definite signs of distress after the ninth day; in the case of daily exposures to 0.12 per cent carbon monoxide, none of the birds showed distress after the eighth day. In another experiment where the birds were exposed daily to 0.22 per cent carbon monoxide, signs of distress persisted even after 20 exposures, but the time interval before falling from the perch had increased to that of a fresh bird exposed to 0.16 per cent carbon monoxide. This is in agreement with the statement made by Royd Sayers that a canary with an acquired tolerance of carbon monoxide can stand twice the concentration of a bird not previously exposed. Comparing these results with the symptoms observed in man on exposure to the same atmospheric concentrations of carbon monoxide, we find that in an atmosphere containing 0.22 per cent carbon monoxide, a bird, whether acclimatised to carbon monoxide or not, will fall from its perch within 12 min., whereas the danger point for a man at rest is not reached in less than 40 min. This gives a moderate margin of safety, so that we may say a bird is reliable as a warning in atmospheres containing more than 0.22 per cent carbon monoxide. Below this atmospheric concentration, however, the reliability of the bird depends on its previous history and on individual idiosyncrasy. In 0.16 per cent carbon monoxide a fresh bird will fall within 23 min., whereas the danger point for a man at rest is not reached for about $1\frac{1}{4}$ hours, but a bird with an acquired tolerance to carbon monoxide may not fall at all in this atmospheric concentration of carbon monoxide. With an atmospheric concentration of 0.12 per cent carbon monoxide or below, a fresh bird may not fall from its perch, although the danger point for a man at rest may be reached in two hours.

United States.- According to Hoffman,[61] from 1921 to 1924 there were 8,719 deaths (2.29 per 100,000 fatal accidents in the United States registration area) from absorption of irrespirable, irritating, or poisonous gas; in 1925 to 1929, the number of deaths was 13,003 (2.32 per 100,000); and for the period 1921-1929, the number of deaths from this cause was 21,722 (2.31 per 100,000).

61 Hoffman, F. L., The Fatal Accident Problem in the U. S.: The Spectator, Jan. 14, 1932.

According to the Ohio Health News[62] deaths still occur from carbon monoxide from various sources. The following is a summary of the cases in Ohio:

A summation of the carbon monoxide mishaps associated with gas-fired heating appliances, reported to the Division of Industrial Hygiene, State Department of Health, for the year July 1, 1930, to June 30, 1931, shows that there was a considerable reduction in the number of fatalities from those of preceding years. In the year 1929-30 there were 52 deaths. The average for the last five years is 44. This year there are 29 deaths, including three from unburned gas, two of which were suicides. In addition, there are newspaper clippings (only) of nine additional cases with three deaths, not included in the above figures.

As to location and type of appliance involved, these cases were pretty well scattered. Space-heaters were associated with 12 deaths, water heaters with 5, gas ranges with 6, and hot-plates with 3 deaths. Twenty-six cases with 6 deaths occurred in bedrooms, 14 cases with 8 deaths in living rooms, 16 cases with 5 deaths in bathrooms, and 21 cases with 5 deaths in kitchens. Heaters in bedrooms and water heaters in bathrooms continue to be among the leading offenders.

The cause or causes of the reduction in the number of deaths this year can only be surmised. Are the people becoming aware of the dangers of faulty or maladjusted gas stoves? Is the publicity given this danger by health officials and newspapers for the past few years having an effect? Whatever the cause, it is to be hoped that the number of deaths will continue to be low and to become lower in the succeeding years.

A faulty water heater in a school basement was the cause of 13 cases, although there was no death. Four cases were reported due to gasoline water heaters and clothes press, with no deaths.

Reports of mishaps from auto exhaust are not so encouraging as those given above. This year there is a considerable increase in the number of deaths from this source. Out of a total of 98 mishaps there were 41 deaths. Last year there were 35 deaths out of 84 cases due to exhaust fumes. All deaths occurred in garages. Five apparently were suicides.

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62 Ohio Health News, Death Still in the Fumes: Vol. 7, No. 18, Sept. 15, 1931, pp. 3-4.

The number of carbon monoxide mishap reports received by the Ohio Department of Health[63] for the first six months of the year 1931-32 has taken a great tumble from the height maintained in previous years. From July 1 to Dec. 31, only 14 reported cases, 7 of which were fatal, were associated with gas-fired heating appliances; 3 of these evidently were suicidal, due to unburned gas, according to records kept by the departmental division of industrial hygiene.

The following table shows the comparative record of cases and deaths reported since 1925:

	Cases	Deaths
1925-26	100	57
1926-27	122	43
1927-28	136	38
1928-29	168	36
1929-30	123	52
1930-31	123	29
1931-32 (1st 6 mos.)	14	7

The above information would seem to indicate that the publicity given this danger by health officials and newspapers for a number of years past is at last having its effect, although the influence of an unusually mild winter can not be disregarded in this year's total. Whatever the cause of the present decline, it is to be hoped that it will continue in succeeding years.

Carbon monoxide is just as poisonous as ever, and in case of carelessness or accident will cause death just as quickly. Vigilance and watchfulness in the proper installation and operation of gas appliances are necessary in order to prevent such mishaps.

Statistics on auto exhaust mishaps for the last six months are not quite so favorable. Here there are 20 cases, 13 of them fatal. The majority of these occurred in closed garages. One fatality occurred while the person was greasing an automobile in a service station. Another man died when fumes were forced up through the car while stranded in a stream of water. One nonfatal case occurred in an automobile salesroom and another in a feed-grinding establishment.

Death by carbon monoxide is considered a compensable accident in Ohio. The death of a workman in a mine from the inhalation of carbon monoxide in the course of his employment was, in the opinion of the court of appeals of Ohio, Carroll County, due to an "accidental injury," within the meaning of the Ohio compensation act, and not to an occupational disease.[64]

63 Ohio Health News, Carbon Monoxide Poisoning: Vol. 8, Jan. 15, 1932, p. 2.
64 Journal of the American Medical Association, Medicolegal: Vol. 97, Dec. 26, 1931, p. 1986.

In New York[65] in 1930, there were 142 fatal accidents from irrespirable or poison gas, 17 of which were public, 105 in the home, 15 industrial, and 5 unknown.

Violations of the smoke ordinance in New York City have been reduced more than 85 per cent during the past year through the efforts of the Health Department, according to Thomas Darlington,[66] head of the trial board for offenders. While the board heard an average of 70 to 80 cases weekly when the smoke abatement work started a year ago, only 8 to 10 cases are now brought each week, he stated.

Most offenders, Darlington said, have not known that they were making smoke and have taken corrective steps after being apprised of their offense.

On the other hand, Darlington explained, it has been found difficult to prove to the courts that smoke from chimneys constituted a health menace. He said he had been informed that in one or two of the cases lost in court, the lawyers' fees for the defense have been far more than the cost of correcting the smoke nuisance.

Darlington held that lack of education as to the harmfulness of smoke was mainly responsible for the nuisance. A survey of the city from tall buildings, he said, would show that at present the air is free, except from the smoke coming from power houses and heating plants, since the private owner has brought about more improvements.

For a long time the problem of carbon monoxide, arising from the contamination of city and garage air by automobile exhaust gas, has been of intense interest, not only to the medical profession, but to the public. The traffic congestion at busy corners in large cities has so increased in recent years that atmospheric pollution by the exhaust gases of automobiles has become an acute health problem. In the past, this problem has not been investigated searchingly, and comparatively little information, which deals directly with the menace from gases from automobile exhausts in traffic, is available. Several years ago, the United States Public Health Service, after a brief survey in a number of American cities, suggested that carbon monoxide is a potential hazard to policemen on long duty at congested city corners. Since then traffic has increased in volume and other changes have occurred, such as in automotive fuels, and these conditions in themselves warrant a thorough-going research.

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65 The Military Surgeon, Fatal Accidents in New York State: Vol. 69, No. 5, 1931, pp. 556-557.

66 Darlington, Thomas, Smoke Violations Reduced 85 Per Cent in New York: Power, vol. 74, No. 19, Nov. 19, 1931, p. 691.

The director of the Department of Public Health, of Pittsburgh, Pa., with a group of collaborating specialists, decided to carry out broad studies of the amounts and effects of carbon monoxide in the air and of certain other health hazards arising from street traffic, and especially from air pollution by automobile exhaust gas, at busy corners in Pittsburgh.[67] The investigation was initiated at conferences held in May, at which there was secured the active cooperation of the Mellon Institute of Industrial Research, the University of Pittsburgh, the United States Bureau of Mines, the city's Department of Public Safety, and the Better Traffic Committee. Data are being secured at busy downtown street corners, and it is expected that the whole survey will require a year.

At each station, continuous records of the amounts of carbon monoxide emitted into the air by automotive vehicles during all hours of the day are obtained. In the apparatus used, the carbon monoxide is determined automatically by an ingenious method devised at the Pittsburgh station of the United States Bureau of Mines. Simultaneous and continuous traffic observations are made at each station in order to ascertain the influence of traffic congestion, traffic disturbances, types of vehicles, and modified automobile exhaust emission upon the prevalence and quantity of carbon monoxide, hydrocarbon vapor, and dust. Later on, the effects of excessive traffic noise will be accorded study.

The apparatus, in charge of officials of the Bureau of Mines and the Mellon Institute, is now installed at the third station to be investigated. Determinations are proceeding satisfactorily, and continuous, 24-hour records are being kept by automatic recorders on the chemical robot that the Bureau of Mines invented and developed. Progress reports will be published from time to time as definite conclusions can be deduced.

This investigation, the first of its kind, will be sufficiently comprehensive to give results on which recommendations may be made respecting the lengths of time, at different periods of the day, that traffic officers can safely be on duty, with proper regard for their health, at the principal corners throughout the city. It will also lead to valuable information concerning the effects of exposure to very small amounts of carbon monoxide over protracted periods.

At present, owing to a dearth of reliable data, medical specialists are uncertain about the action of traces of the gas on human beings, when the latter inhale such minute amounts regularly, several hours a day, year in and year out, on streets and in bordering buildings. It is known that carbon monoxide is an extremely fugacious and diffusible gas that quickly leaves its source, ascending to levels above the street. The investigators will try also to learn about the carbon monoxide producing effects of different types of cars, of various ways of operation, and of changes in mufflers.

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67 Pittsburgh's Health, Air Pollution by Carbon Monoxide: Vol. 2, No. 18, Sept., 1931, pp. 66-67.

The following statement has been made by Newell[68] in regard to poisoning by natural gas:

> Natural gas as it comes from the wells in Oklahoma is made up of a mixture of methane, CH_4, and ethane, C_2H_6. These are gases at ordinary temperatures. Hydrocarbons of a higher weight than this are liquids or solids at ordinary temperatures. Gasoline and kerosene are the lighter forms next to natural gas. Some of the gas, however, is very heavy in gasoline, of which ethane is a principal part, and the symptoms of gasoline vapor poisoning seem to dominate in natural gas poisoning. Methane itself seems to be a rather inert gas with no odor. Its presence has been demonstrated in old wells and mines by the extinguishing of a lamp. There is little effect produced by methane other than a deficiency of oxygen. Ethane or gasoline fumes, however, produce the toxic results.
>
> It has been found that breathing from 10 to 15 gm. of gasoline in eight minutes causes dizziness, nausea and drowsiness. Inhaling from 30 to 40 gm. in ten to 12 minutes produces anesthesia. Tested on dogs, it was found that breathing a dilution of 85 parts to 10,000 of air caused drowsiness, and if the concentration was increased to 156 parts the animal would fall. Recovery followed when removed at this moment after a few clonic spasms. A dilution of 192 parts caused the dog to lose consciousness and recovery followed after several convulsions. One dog died when a concentration of 243 parts to 10,000 was reached.
>
> Men sent into tank cars without the proper protection often exhibit symptoms of mild mania, and refuse to leave the tank. They shout, sing, and often lose consciousness before they can be forced out. They seem to lose their reasoning power. Their pulse is rapid, then slow, temperature falls and skin becomes cyanotic. Some die from the exposure, in spite of the fact that oxygen may have been supplied at the same time they received the gas fumes.
>
> From the Bureau of Mines we have a statement that they have found a 2½ per cent gasoline vapor with a high per cent of oxygen that would make one dizzy, and soon become intolerable.
>
> Natural gas is piped into our homes under a pressure of from 4 to 6 ounces. Users are very careless in connecting these pipes to their fixtures and leaks are often the result. Breathing this gas has the same effect on the economy as the fumes of gasoline. At first there is a little dizziness, and possibly a headache. Next a feeling of numbness and analgesia, followed by anesthesia, and unless removed from the atmosphere of the gas, convulsions, unconsciousness and death follow.

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68 Newell, W. B., Poisoning from Natural Gas and Its Combustion Products: Internat. Med. Digest, Hagerstown, Md., vol. 19, Dec., 1931, pp. 327-328.

Recovery is prompt when patient is removed, but headache and a wretched feeling follow, and continue for one or two days. In severe or prolonged gassing, various late nervous effects are reported, such as weakness of the legs, vertigo, nystagmus and tremors.

The chemical and pathological reaction of dogs to asphyxia by carbon monoxide and by atmospheres which are deficient in oxygen has been studied during the past two years by the United States Bureau of Mines.[69] These studies have been conducted for the purpose of obtaining fundamental information on the response of the organism to asphyxial environment, with the particular object of devising a procedure for treating moribund cases of carbon-monoxide poisoning. It has been repeatedly observed that many of these cases have a fatal termination, even though respiration has been induced and the carbon monoxide removed from the blood.

The results of the first of the series of these studies, on neuropathology resulting from asphyxia, are summarized by the authors as follows:

> The neuropathology produced in dogs by fatal exposures of 20 to 30 minutes to 0.6 per cent carbon monoxide in air by volume was studied.
>
> The brain, as a whole, showed a severe perivascular and perineuronal edema. This was most marked in the corpus striatum, the cortex, and the dorsal motor nucleus of the vagus nerve. The vessels were greatly dilated and tightly packed with red blood cells. Stasis was marked throughout. There were a few petechial hemorrhages, especially in the corpus striatum and cortex. Most of these were not larger than would occur by diapedesis through the dilated vessels. Occasionally a few leucocytes, both lymphocytes and polymorphonuclear leucocytes, were found in the perivascular spaces. The endothelium of the capillaries appeared to be swollen in some areas.
>
> The neurons were extensively damaged. Many of the nerve cells seem to have been ruptured. In some areas all that appeared to be left of the nerve cell was a swollen, distorted, and vacuolated nucleus with a little Nissl material around it. A clear space marked the site of the original cytoplasm of the neuron. In others there was a marked central chromatolysis with distorted nuclei. This was most pronounced in the cells of the nuclei pontis. The Nissl material was dust-like in some of the very large cells, as in some of the neurons of the nucleus ruber. In others the Nissl granules were abnormally large and decreased in number. Some of the cells, especially the small pyramidal cells in the cortex and the cells of the dorsal nucleus of the vagus, were shrunken and stained homogeneously a dark blue. The nuclei were swollen, distorted in shape,

69 Chornyak, John, and Sayers, R. R., Studies in Asphyxia. I. Neuropathology Resulting from Comparatively Rapid Carbon-Monoxide Asphyxia: Pub. Health Repts., vol. 46, No. 26, June 26, 1931, pp. 1523-1530.

and frequently eccentric. They contained very little chromatin material. Many of the nerve cells were shrunken.

Many of the large polygonal-shaped cells containing well-developed Nissl granules, located throughout the reticular formation of the brain stem, showed practically no change. Likewise, the nuclei of the hypoglossal, abducens, trochlear, oculomotor nuclei, and nucleus ruber showed relatively little damage. The dorsal motor nucleus of the vagus nerve, dorsal sensory areas of the brain stem, the corpus striatum, and the cortex showed severe injury.

There was a variation in the degree of damage with different animals. With three of the four dogs studied the variation was not marked, but the fourth showed distinctly less damage. The foregoing findings were, however, present to some degree in all of the animals.

The following conclusions may be drawn:

1. The circulatory changes are characterized by dilatation, stasis, perivascular hemorrhage, and edema.

2. Edema is diffuse and severe. It is both perineuronal and perivascular.

3. There is a marked difference in the susceptibility of the nerve cells to oxygen deprivation. The cells of the cortex, corpus striatum, dorsal motor nucleus of the vagus, and the dorsal sensory areas of the medulla, are the most sensitive. The nucleus ruber, nuclei of the oculomotor, trochlear, abducens, and facial nerve, and the large polygonal cells in the reticular formation of the medulla are the least susceptible.

4. There are two general types of degenerative changes in the nerve cells following asphyxia: (a) Some become shrunken and stain diffusely; (b) others show varying degrees of chromatolysis.

5. Carbon monoxide produces a diffuse degenerative change throughout the entire brain.

6. In this type of asphyxia the most serious effect appears to be edema of the dorsal motor nucleus of the vagus and the adjacent area in the medulla oblongata.

The following is the summary[70] of the second series of the investigation which dealt with the blood chemical changes resulting from comparatively rapid asphyxia by atmospheres deficient in oxygen:

> A study was made of blood chemistry changes in dogs exposed to atmospheres which were depleted of oxygen at a rate which caused a progressive asphyxial condition simulating asphyxia resulting from exposure to approximately 0.6 per cent carbon monoxide in air by volume. The conditions caused death in 11 to 18.5 minutes. The study was made not only to ascertain the changes attending asphyxia by insufficient atmospheric oxygen, but also as a parallel to a similar study of the changes attending asphyxia by carbon monoxide in order to ascertain if there were changes which were peculiar to each type of asphyxia or if they were identical and due entirely to anoxemia.
>
> 1. There was a marked hyperglycemia and hyperuricemia; the non-protein nitrogen and urea increased slightly; the total and preformed creatinine remained practically normal; and the inorganic phosphorus increased.
>
> 2. There was an increase in the hydrogen ion concentration and a marked decrease in the carbon dioxide capacity of the plasma, and the carbon dioxide content of the blood.
>
> 3. The oxygen saturation of the arterial blood at death ranged from 1.3 to 8 per cent.
>
> 4. The red blood cells increased in one case, but showed no significant change in two. The white blood cells and polymorphonuclears increased while the lymphocytes decreased.

Barcroft and Margaria[71] have experimentally investigated the effect of CO_2 inhalation upon human respiration. They find that the rates of both inspiration and expiration are quickened, and that the time taken by each phase is shortened. The rate of inhalation of air at the middle of inspiration varies almost exactly with the total ventilation. These variations were found by the authors to be the same for a person, whether the hyperpnoea was produced by CO_2 inhalation or by exercise. The maximum total ventilation produced by exercise was nearly twice as great as that produced by the highest concentration of CO_2 which could be breathed for a quarter of an hour. The authors conclude, therefore, that CO_2 inhalation and exercise act in a similar way, but that the maximal effect of the first falls short of that of exercise. The breathing of 7.5 per cent of CO_2 for 20 minutes produces a shock from which the system does not wholly recover for some hours. It seems clear that carbon dioxide can only be one contributory factor in the production of dyspnoea by exercise.

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70 Schrenk, H. H., Patty, F. A., and Yant, W. P., Studies in Asphyxia. II. Blood Chemistry Changes Resulting from Comparatively Rapid Asphyxia by Atmospheres Deficient in Oxygen: Pub. Health Repts., vol. 47, No. 3, Jan. 15, 1932, pp. 136-146.

71 Barcroft, J., and Margaria, R., Pathology. Effect of Carbon Dioxide on Respiration: British Med. Jour., No. 3688, Sept. 12, 1931, p. 42.

According to Heating Piping and Air Conditioning,[72] in the light of our meager knowledge of the effects of atmospheric pollution on health, it is fair to say that any conspicuous air pollution constitutes a liability to property and health, and that steps should be taken to reduce the pollution to a minimum. This would require the concerted efforts of the fuel engineer, the public health officer, and the public itself.

SUMMARY OF RECENT LITERATURE ON ABNORMAL TEMPERATURES AND HUMIDITIES

Australia.- Attention was recently drawn to the occurrence of boils and carbuncles among miners by the number of men at a certain colliery who were afflicted with them.[73] Inquiries at this mine made evident various factors, any of which might have been the cause of the cases found. Of these factors, three were outstanding: (a) The temperature at the working face--dry bulb, 90°F, wet bulb 80°F; (b) the hardness of the drinking water; and (c) the fact that most of those suffering from boils were men who had been off work for terms up to two years and who were newcomers to the district. In order to determine more exactly which of these factors was the material one, 20 other collieries were visited and information was received from 20 more. About 200 men were examined or interviewed. The investigation at the various collieries resolved itself into two parts--namely, examination of the men and examination of conditions at the mine. The depths of the mines visited ranged from 300 to over 1,000 yards, and the distances inby to the working places up to 2½ miles. The highest temperature met with at the face was 93°F. dry bulb and 85°F. wet bulb; the lowest was 53° dry and wet bulb. In mines where the wet bulb temperature was about 75° or over, the men worked partially stripped--that is, in shorts and boots--and the occurrence of boils was most noticeable in mines where the temperature at the face reached or passed 75°F. It was observed, too, that boils occurred more often on men who sweated profusely and whose bodies were covered with a fine film of wet coal-dust--as one may put it, "the body is as if covered with boot polish."

It was concluded that, as far as mines are concerned, boils do not present a serious problem, except in a few isolated cases, and that the main factor in the causation of boils underground (apart from the predisposition to them of the individual--e.g., malnutrition, seborrhea, etc.) is a high wet-bulb temperature (75° and over) which at one and the same time indicates suitable conditions (warmth and moisture) for the vitality of the organism, and opens the sweat glands and hair follicles and thus facilitates the entry of the staphylococcus.

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72 Heating, Piping and Air Conditioning, Atmospheric Pollution: Nov., 1931, p. 932.

73 Fisher, S. W., Boils and Carbuncles Among Miners: Queensland Govt. Min. Jour., vol. 32, Sept., 1931, p. 368.

The treatment recommended was the use of manganese injections and treatment of the local lesion by painting it with contracile collodion. To the managers of mines where boils occur, it was suggested that every effort should be made to improve the ventilation, lower the temperature, and minimize wetness. The men were advised to apply an antiseptic, preferably tincture of iodine, to the smallest scratch, cut, or boil as soon as possible and to avoid touching the boil with the fingers, to drink as little water as possible, and preferably water with a small amount of salt added to it (about 10 grams to the gallon), and whenever available to make full use of pithead baths.

England.- The following report[74] is made of an investigation carried out in 1927-1928 on the relationship of absenteeism to the atmospheric conditions experienced underground in the 10 collieries described in the previous report for the years 1924-1925:

> The present results relate to the men working in 13 different localities, and the results obtained in the two statistical periods correspond fairly well in most of the localities, but in order to demonstrate clearly the relationship of accidents to temperature it is necessary to re-classify the data in temperature groups. At dry-bulb temperatures of less than 70° the coal-face workers suffered 133 accidents in 1927-28, as against 104 in 1924-25. At temperatures of 70° to 79° the frequency experienced in the two periods was exactly the same, but at temperatures of 80° and upwards it was 173 in 1927-28, as against 184 in 1924-25. That is to say, in both statistical periods a rise of temperature was associated with a rise of accident frequency, but the rate of rise was not half as great in the later period as in the earlier one. The severity rates of the coal-face men showed an even greater diminution of response to temperature in the later statistical period, but the other underground men showed the reverse relationship, as their severity rates responded more to temperature in 1927-28 than they did in 1924-25. Their frequency rates did not differ much in the two periods.
>
> The frequency rate (per 100,000 shifts) and severity rate of accidents in relation to air velocity have been recorded for both statistical periods. In 1927-28 the coal face workers attained a minimum accident frequency of 94 when the air velocity was 40 to 59 ft. per min. and its temperature was 72.2 deg. In air at a velocity of 30 to 39 ft. the frequency was 129, but the temperature was 78.5 deg., and this rise of temperature would increase the accident frequency 7 per cent. Apparently therefore the observed difference of accident frequency could have been due only in small part to a temperature effect, and the same thing is true of the much greater accident frequency observed at velocities of 60 to 80 ft. The other underground men showed, in 1927-28, a much smaller accident frequency

74 The Colliery Guardian, Absenteeism in Relation to Atmospheric Conditions: June 5, 1931, pp. 1890-93, 1977.

at velocities of 150-199 ft. than at either lower or higher velocities, though the 1924-25 data showed a minimum frequency at the lowest velocities. Both statistical periods showed their maximum frequency at the highest velocities, though part of this excess of accidents was due to higher air temperature.

The accident severity rates ran roughly parallel with the frequency rates in both statistical periods, so it may be concluded that both classes of workers showed a genuine increase of accidents at high air velocities. It is probable, though less certain, that they attained their minimum accident frequency at moderate air velocities and suffered an increase of accidents at low velocities. This second conclusion is what we should expect, for it is well known that men engaged on heavy work are more efficient if the cooling power of the air is raised by increasing the degree of air movement. The rise of accidents experienced at higher velocities may be due to the fact that the men often have to wait for periods of several minutes at a time owing to shortage of tubs, etc., and as they are very lightly clad they are apt to get chilled and stiff, and on that account more clumsy and liable to accident. The coal face men usually wear less clothes than the other underground men, and therefore respond to air currents of lower velocity.

The accident rates for the younger men corresponded fairly well with those observed in 1924-25, but the coal face men of 50 and upwards showed an 18 per cent increase in frequency rate, and a 41 per cent increase in severity rate, over the 1924-25 figures. The other underground men of 40 and upwards showed increases of 9 and 30 per cent on the 1924-25 figures. These increases may have been due to the greater fatigue incident to the longer working day. They related especially to the men working at temperatures above 70 deg., and each accident to the older men entailed an absence from work which was, on an average, 22 per cent greater than in 1924-25.

Voluntary absenteeism appeared to be closely associated with the labour turnover at the various collieries, and with the distance the men had to walk underground from pit bottom to working place. It was also related to the distance of the homes of the men from the colliery.

Results of a similar study[75] at Scottish colliers are reported below:

The Health Advisory Committee of the Mines Department decided that a field inquiry should be made at certain selected mines in order to see if any factor or factors might be traced which would account for the divergent sickness rates observed. The present report described the results of such an inquiry.

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75 The Colliery Guardian, Absenteeism in Coal Mines: Vol. 142, No. 3676, June 12, 1931, pp. 2058-2059.

In all, 190 sets of observations were made, an average of 27 per colliery. Of these observations 137 were made at the coal face and the remaining 53 in the haulage roads. Of the Fifeshire pits, those with low sickness rates (A and B) had lower average temperatures than the others, and their cooling powers were higher than those at collieries C and D. At these two latter collieries the air was more humid than at collieries A and B. In many parts of the traveling roads at collieries C and D the air was quite misty through condensation of moisture. The air velocities shown for collieries D and E are somewhat higher than those at the low sickness collieries A and B, but during the last six years a new fan has been installed at colliery D and the ventilation has been greatly improved generally.

Although the temperatures at the other colliery with a high sickness rate (colliery E) are rather higher than at collieries A and B, the cooling powers are much the same, and it cannot be suggested that the physical qualities of the atmosphere account for any difference in the sickness rates. Colliery E is connected underground with a larger colliery owned by the same company, and is ventilated by the spent air from this other colliery. It seems very doubtful whether this fact is sufficient to account for the higher sickness rate observed, but this is the only respect in which the atmospheric conditions appear to be inferior to those at collieries A and B.

Turning to the two Midlothian collieries, it is seen that, although the cooling powers are much the same, colliery F, with the lower sickness rate, is distinctly better ventilated than colliery G. The air velocity at the coal face at the former pit averaged 227 ft. per min., as compared with an average of 47 ft. at the latter. During the period to which the sickness experience relates the difference would be much more marked, for in the last five years the ventilation of colliery G has been completely reorganized and greatly improved. Previously, this colliery was ventilated by the return air from another colliery, but within the last five years a shaft has been driven from the surface to act as an intake to the various seams: In former years there was much black damp, and when the atmospheric pressure was at all low men frequently had to leave the pit in the dark because their lights had failed. It can confidently be said that at the time of the sickness experience the cooling power of the air would be distinctly lower at colliery G than at colliery F.

While it is not possible to point to any single environmental factor, i.e., an excessively high temperature, as being responsible for the differences between the sickness rates at the various collieries, it does seem possible that these differences may be attributable to the combined operation of the environmental factors

discussed. The atmospheric conditions were generally not as good at the collieries with high sickness rates as at those with low rates. Though the differences observed were not great it is possible that prolonged exposure to such inferior conditions, while arduous work is being done, may account to some extent for the higher sickness rates observed. Other conditions also may be partly responsible for the differences between the sickness rates of collieries F and G. The men at colliery F are much the better housed, and live nearer to their work. It has also been mentioned that, while there was a good deal of water along some of the coal faces at colliery G, colliery F was fairly dry, also, the work of coal getting was probably more exacting in the vertical workings of colliery G than in the more moderately inclined workings of colliery F.

Absenteeism of surface workers varied between 1.5 and 5.0 per cent. The investigators are not able to suggest the causes of this variability, but it is interesting to note that at colliery A (a very gassy pit), where the underground workers' absenteeism amounted to 10.6 per cent, the surface workers lost only 1.8 per cent of possible time. The objection to working at a gassy pit does not apply in the case of surface workers, and they probably form a good deal more stable population than the underground workers.

According to Bedford,[76] certain observations on working capacity of coal miners in relation to atmospheric conditions suggested that in a hot, dry mine it might be possible to improve conditions by means of artificial humidification, and an experiment was carried out at a certain colliery. The results showed that where the rate of heat emission was low, the cooling influence of the humidification was felt over a reasonable distance. When the atomizers were situated 120 yards from the coal face the air temperature 85 yards beyond them was still 3° lower than with normal ventilation. However, when the rate of heat emission was high, as along the coal face, the cooling effect of conditioning was soon lost. For instance, although the conditioned air reached the cool face 7.8° cooler than under normal conditions, by the time it had traveled along 35 yards of face this difference was reduced to 1.0°. The experiment was carried out under favorable conditions, in a district with good ventilation. With a more sluggish ventilation the rise in temperature after conditioning would probably have been much more rapid. It was concluded that air conditioning by artificial humidification is not likely to be of value for general application in hot and dry mines. The method might, however, be used in such mines as a palliative measure in certain isolated circumstances, always provided that the humidification could be done quite close to the working position. The real solution of the high-temperature problem appears to be the provision of large volumes of rapidly moving air.

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76 Bedford, T., and Warner, C. G., The Reduction of Mine Air Temperatures: Colliery Guard., vol. 143, No. 3687, Aug. 28, 1931, pp. 699-700.

An investigation of atmospheric conditions in hot and deep mines is being carried out under the supervision of Graham at the Birmingham University Mining Research Laboratory and also at a number of collieries.[77] The investigation falls naturally into two sections: The examination of atmospheric conditions and methods for their possible improvement, and the determination of the physiological effects of these conditions.

Tests have been carried out both in the laboratory and underground to determine the effect on atmospheric conditions of increasing the velocity of the air current and the most efficient means of attaining an increased velocity. Local circulation by means of a fan and the use of an auxiliary fan as a booster have both been tried, and under the conditions of test the latter arrangement has shown a distinct advantage. Natural ventilation has been studied in a Lancashire colliery and similar observations are to be made in north Staffordshire.

In connection with the examination of the effects of ventilation, observations have been made on airway resistance and leakage. For their more precise measurement, attempts are being made to devise an instrument of increased sensitivity and accuracy.

The physiological researches have included observations of the effect of periods of rest and work in warm and moist air at temperatures lower than normal body temperature. Results on this phase are being prepared for publication.

Bonnardel and Langier[78] summarized work that has been done in an artificial mine 8 meters long and having a cross section of 2½ meters. It contains devices for ventilation (fan delivering 10 cubic meters per second), air heating (gas boiler generating 18,000 calories per hour), humidification (helicoidal fluid jet atomizers) which thus permit of varying the ventilation, the temperature, the hygrometric degree, and of obtaining temperatures of 40° C., in an atmosphere saturated with moisture, with an air velocity reaching 6.40 meters in a gallery 1 meter in height. The essential results are as follows:

(1) Ventilation and Circulation.- The ventilation, with the subject in repose, brings about a reduction in the maximum arterial pressure, particularly at high temperatures; during the work the increase in pressure is diminished by the ventilation.

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77 The Colliery Guardian, Safety in Mines Research Board Ninth Annual Report: Vol. 143, No. 3689, Sept. 11, 1931, pp. 901-902.

78 Bonnardel, R., and Langier, H., The Physiology and Psychology of Work: Colliery Guard., vol. 143, No. 3696, Oct. 30, 1931, p. 1502.

(2) Ventilation and Respiration.- (a) When the effect of the wind becomes manifest in symptoms of cold, no matter how slight (goose flesh, etc.) the amplitude of the respiration, the production of CO_2, the consumption of O_2, and also the emission of vapor by the respiration are much higher than in a calm.

(b) Under average conditions in which the effects of the wind or calm on the sensation of warmth are deemed to make no difference, the amplitude of the respiration and of the production of CO_2 are not affected by the wind, but the emission of vapour decreases considerably in the wind.

(c) In cases (high temperatures of over 30°) in which the wind produced an agreeable sensation, the amplitude of the respiration increases under the action of the wind, the production of CO_2 diminishes slightly, and the emission of vapor decreases considerably.

(d) At extremely high temperatures, i.e., air warmer than the body, the amplitudes of respiration and also the production of CO_2 are greater in the wind than in a calm, the emission of vapour being considerably greater in the wind than in a calm.

(3) Study of the Loss of Water.- In repose, the ratio between the water lost by respiration and the water lost through skin (evaporatory quotient of Boussaguet) is about 40 per cent. During work it falls to 12 to 16 per cent. In a dry atmosphere a ventilation of 2 to 3 m. per sec. may cause this quotient to fall below 2 per cent. On the other hand, "any deviation in temperature between the dry thermometer and the wet thermometer of less than 4°, when the wet thermometer is above 24°, indicates a surrounding atmosphere incompatible with the physiological working conditions."

(4) Action on the Thermal Regulation.- The ventilation distinctly assists the thermal regulation.

(5) Effect on the Efficiency.- In comparing the work done with the quantity of CO_2 evolved, Langlois and Routheir conclude "that, in an atmosphere having a temperature adjacent 25° on the wet thermometer, an air stream striking the worker at a velocity of 1 m. per sec. considerably increases his efficiency."

(6) Effect on Pathological Conditions.- Investigations on animals; comparison of working conditions on normal guinea pigs and tuberculous guinea pigs. The hypothermia, which is a function of the hygrometric state, is more pronounced in tuberculous animals than in healthy animals, and the consequences, which are mild in the case of the healthy animal, are serious in the sick animal.

Vernon,[79] who dealt with the influence of the humidity of the air on working capacity at high temperature, recalled the statement by Haldane that the wet-bulb temperature alone has to be considered in measuring the maximum temperature which can be borne by men (e.g., miners) performing mechanical work at high temperatures, and that the dry-bulb temperature can be ignored. On the other hand, Yaglou and his colleagues maintain that the dry-bulb temperature of the air exerts a considerable influence, as well as the wet-bulb, and they have combined the three factors of dry-bulb temperature, wet-bulb temperature, and air velocity into a single measure, which they term the effective temperature. For instance, still air with both wet and dry bulb temperatures at 70° F. would have an effective temperature of 70°, but if the wet bulb was 70° and the dry bulb 100° the effective temperature, according to their charts would be 80.5°, or 10.5° higher. Yaglou accordingly suggests that the air in hot mines ought to be conditioned by increasing its humidity by means of a water spray. In order to obtain further information, two subjects have performed a number of 3-hour experiments in air at a wet-bulb temperature of 70°, 75°, 80°, and 85°, and at a velocity of 93 feet per minute. One subject performed mechanical work roughly corresponding to the work of a coal miner (14,400 kilogram-meters per hour). His pulse rate increased with rise of wet-bulb temperature, but in dry air 40 per cent saturated with moisture the mean pulse rate, at a given wet-bulb temperature, was about six beats per minute higher than in air 60 per cent saturated with moisture and 10 beats higher than in moist air 95 per cent saturated with moisture. On the other hand, the pulse increased steadily as the effective temperature increased, whether the air was dry or moist. The pulse of the other subject, who performed very little mechanical work, also corresponded with the effective temperature scale and not with the wet-bulb temperature. The effects were smaller in summer than in the winter, owing to acclimatization. The body temperature of both subjects rose slightly with rise of effective temperature. The skin temperature, which was taken by means of a Moll thermopile, rose steadily with rise of dry-bulb temperature. The oxygen consumption of the subject was fairly steady at all temperatures, but it reached a minimum at 76° and rose 3 per cent at higher effective temperatures. Both subjects felt considerably more fatigued after remaining for three hours in dry air than in moist air of the same wet-bulb temperature. The subjects made a number of preliminary experiments in order to get themselves acclimatized, but acclimatization effects can never be entirely avoided. For instance, when four consecutive experiments were made in dry air at 100° (dry bulb) and 80° (wet bulb) the mean pulse rate of the subject doing mechanical work fell gradually from 121.2 to 117.2, while the loss of sweat increased from 16.8 to 20.2 ounces per hour. The next three experiments were made in moist air at 81° (dry bulb) and 70° (wet bulb), and the sweat amounted to 17.7, 12.7, and 10.8 ounces, respectively (i.e., it fell gradually as the effect of the preceding dry-air experiments wore off).

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79 Vernon, H. M., Effect of Humidity on Working Capacity: Colliery Guard., vol. 143, No. 3696, London, Oct. 30, 1931, p. 1502.

France.- The following interesting statement regarding the methods of experimentation used in the United States was published recently in Chaleur & Industrie:[80]

> We have already published, either in the review or in the different volumes devoted to the works of the last Congress on Heating and Ventilation, a certain number of studies on the ideas of effective and equal comfort temperatures to which the Americans have devoted such long and costly researches.
>
> The usefulness of these ideas one will judge by reading the remarkable study that M. Missenard-Quint has just given us on the subject.
>
> And we will add that, in a letter which accompanied his article, our collaborator has given us some very curious details on American methods of working. We do not think that we can do better than to reproduce them here. *****
>
>> The Americans, our collaborator tells us, have dispensed enormous sums in studying the ideas of comfort and effective temperature which they have finally summarized in a graph.
>>
>> All these studies, as almost the totality of American investigations, have been made by pure empiricism, which is a guarantee of their exactitude with good experimenters; but the process can be used only by that nation whose pecuniary resources are almost unlimited. *****
>>
>> Moreover, it ensues from all my technical relations with the Americans that their form of culture does not lead them to theoretical researches, for which they have little taste in general.
>>
>> The following study, which makes use of some of their experiments (the thousandth part, perhaps, of their empirical work), permits by theoretical considerations not only the coordination and explanation of their results but their generalization by increasing the number of variables they propose to make empirically but have not yet realized.

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80 Missenard, A., Temperature Effective d'un Atmosphere Temperature Resultante d'un Milieu: Chaleur & Ind., vol. 12, No. 137, Sept., 1931, pp. 491-498; No. 138, Oct., 1931, pp. 553-557.

Some of the American engineers, to whom I have spoken of this work, have been astonished that one can save the millions of dollars spent on their laboratory researches by pure theory based on a rather restricted number of tests.

They have, in fact, insisted that I communicate this work to them to be published in American journals and in particular the Journal of American Society of Heating and Ventilating Engineers. I refused, believing that it should be published first in a French journal, in which, moreover, the readers perhaps could express some interesting objections.

Germany.- Strauss and Walther[81] state that they determined through various experiments that for the present neither the "effective temperature" of the Americans nor Hill's kata degree offers a reliable basis for the comprehension of atmospheric effects on human beings. They summarize the results of their investigations as follows:

Neither in the body nor in the skin temperature and especially in elimination of water is the influence of (high temperature) moving air prominent in the cooling of the working body. The physiological significance of air movement bears no relation to the alteration of the cooling power of the atmosphere conditioned thereon, as it finds its physical expression in kata degree.

In this connection we would not overlook the fact that the body through movement at work itself creates a light fanning air movement which in our case amounted to 0.3 m./sec. and with the naked body might indeed prevent stagnation of the air in closest proximity to the body.

Everyone who in a hot climate has hunted the pleasantness of moving air will oppose the idea of this slight objective value of the wind. Since ventilation does not result in cooler air, or weaken the action of radiation or, with the body clothed, remove the vapor-saturated atmosphere between the skin and clothing, as is very significant objectively, one must distinguish between objective and subjective effect. Also our subjects - if it did not reach too high a degree (28° and 2 m./sec. air circulation was badly borne) - found the atmosphere agreeable. This influence, however, was very transitory; no one experienced an essential lightening of the work, especially was the feeling of strain after the work entirely the same, and the necessity for relaxation always given in the same measure. Temperature and humidity acted on the capacity for work and the feelings to a far higher degree than did the air movement.

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81 Strauss, W., and Walther, K., Klima und Arbeit. II. Mitteilung. Der Einfluss ruhender und bewegter warmer Luft auf die Entwärmung des unbekleideten, arbeitenden Menschen: Arch. Gewerbepath. und Gewerbehyg., vol. 1, No. 5, Jan. 15, 1931, pp. 634-655.

The significance of the subjective factor is not undervalued. In industrial processes one must very often grasp the means of alleviating the subjective because one can not do much with the objective; but one should not deceive himself regarding the relatively slight objective value of such measures. We need only to point out that the highest temperature in our experiments did not reach the atmospheric limit for industrial work, that, for example, work is carried out at higher temperatures in mines at home and abroad. Our own experiences in such industries have taught us to see the subjective significance of air movement, as well as the danger which lies in a valuation of the atmosphere somewhat according to the kata degree. The body reacts - as has been emphasized repeatedly - otherwise than the physical instrument. In any case we have found no relation between kata degree and physiological reaction, and therefore we can not resolve to consider the kata value - so long as no other physiological and objective criterion is brought forward for its usefulness - as a measure for the estimation of climatic action on human beings. The special advantage of the kata thermometer, that is, high sensitivity to the fine and finest air streams, is expressed much earlier in the climatic-meteorological study.

Recently the "cooling power" of a climate has aroused the greatest interest as a new, comprehensible conception from the standpoint of industrial hygiene. Under the supposition that this conception is not only meteorologically clear but also physiologically correct, one dares hope to attain in industrial establishments, for example, such as mines, a greater cooling power and thereby greater relief to the workers through increase of ventilation. Our experiments indicate forcibly that such relief is not so simple to bring about and is only to be expected when the indrawn atmosphere, aside from the addition of fresh air, also at the same time lowers the temperature at the working place. Air movement in itself is not of decisive influence on the cooling of the body.

United States.- According to Heating, Piping and Air Conditioning,[82] many accidents and sicknesses may reasonably be ascribed to, and in many instances are definitely proved to be, the result of bad air. Accidents are avoided in many cases by mental alertness, and while the mental effects of poor air conditions are not measurable, we know from the physiological effects that they must be great. A clearer knowledge of the underlying causes of accidents would be desirable. It is not sufficient to locate and measure hazards; more should be known about contributing conditions, such as poor air and poor lighting. There is no doubt that the conditions surrounding employees have a lot to do with accidents; more specific data are needed.

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82 Heating, Piping and Air Conditioning, Air Conditioning Prevents Accidents: Vol. 3, No. 9, Sept., 1931, p. 807.

During the past two years the Harvard School of Public Health, in cooperation with the Research Laboratory of the American Society of Heating and Ventilating Engineers,[83] has been studying the problem of ionization in relation to air conditioning and health. Several phases of the work dealing with diurnal and seasonal variations in the ionic content of outdoor and indoor air, ionic changes due to respiratory and metabolic processes, and the deionizing effects of air conditioning methods have already been completed. The phases of the work now being studied are:

a. Physiologic, bacteriologic, and biochemical effects of artificially ionized and de-ionized air.
b. Relationship between seasonal variation in atmospheric ionization and seasonal variation in the incidence of respiratory diseases.
c. Methods for artificial ionization of air.

Other plans of the committee for future work include the physiologic, bacteriologic, and biochemical effect of cold and of humidity on human beings and animals.

Very little information is available on the effects of cold upon the organism. The region covered by the Research Laboratory extends from 80° E.T. upward. In the opinion of the committee, the Research Laboratory should complete this work, which, in conjunction with the study on ionization, may throw some light on the etiology of respiratory diseases.

Concerning the influence of humidity on the organism, the committee proposes a thorough study of the effects of changes in humidity through a range of 60 per cent at three different temperatures, namely, 40°, 70°, and 95° F., with the possibility of determining the optimum humidity zone. Observations are to be made on men as well as on animals. The observations on animals are to include the course and resistance to pneumococcus and enteric infections at high and low humidities, growth, reproduction, etc.

Intensive investigations have until now failed to discover the specific cause of deadness, or lack of a stimulating quality, in the air of occupied rooms, even when temperature and humidity are controlled, as contrasted with the air of the open country. Proponents of the open-air treatment ascribe this quality of freshness to a vital principle which is lost when air is brought indoors, particularly when ventilation is effected by mechanical means.

In recent years, since the carbon dioxide, oxygen, and crowd poison theories have become obsolete, ionization has been suggested as the air-soluble vitamin, but it has not yet been identified. The virtues of artificially ionized air have been extolled on purely theoretical grounds, with no scientific confirmation whatever.

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83 Heating, Piping and Air Conditioning, (Report of Technical Advisory Committee, C. P. Yaglou, Chairman), Air Conditions in Relation to Comfort and Health: Aug., 1931, p. 712.

A series of experiments[84] was carried out on ionization in relation to ventilation and health in occupied and unoccupied rooms with no ventilation, with window-gravity ventilation, and with mechanical ventilation, in order to determine the extent to which the number of small ions is affected by respiration and transpiration, and by modern air-conditioning methods. In contrast with the prevailing belief, the ionic content in unoccupied heated rooms did not differ much from that out of doors, and in cold weather it was often higher, owing probably to a temperature effect. In occupied rooms there was a marked decrease in both positive and negative ions. Immediately after the occupants assembled, the ionic content of the air fell abruptly to a very low value, which was maintained until the occupants left the room. Both positive and negative ions began to rise again as soon as the people departed.

The minimum supply of outdoor air required to maintain normal ionic content in a crowded room was found to be prohibitively high (160 c. f. m.per person). With the usual air supply of 30 c. f. m. per person, the ionic content did not seem to differ greatly from that with no ventilation at all. On the other hand, it was possible by means of artificial ionization to control both the quantity and the quality of ions at any desired concentration up to 10,000 ions per cubic centimeter, with or without ventilation. Mechanical ventilation reduced the ionic content from 0 per cent to 30 per cent by diffusion and adsorption to metal conductors. Heating the air by means of a central fan system increased the ionic content, and cooling by similar methods decreased it. The usual methods of washing, humidifying, or dehumidifying by means of water sprays deprived the air of all small ions and produced a great number of large negative ions, or condensation nuclei, by the well-known Lenard effect. Recirculation reduced both positive and negative ions by diffusion and adsorption to metal conductors.

Houghten[85] and co-workers report the results of 135 heat balance tests made on five subjects in various atmospheric conditions and performing work on a work machine by raising and lowering a weight. Heat quantities were determined by observations of the metabolic rate, and balances were computed by assuming that the total heat dissipated from the body equals the heat production minus the heat storage in the body minus the heat equivalent of the work done on the work machine. This quantity is broken down into sensible and latent heat by assuming that the weight loss is due to evaporation at body temperature. The following is a summary of the results of these tests:

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84 Yaglou, C. P., Benjamin, L. C., and Choate, S. P., Changes in Ionic Content of Air in Occupied Rooms Ventilated by Natural and by Mechanical Methods: Heating, Piping and Air Conditioning, Oct., 1931, pp. 865-869.

85 Houghten, F. C., Teague, W. W., Miller, W. E., and Yant, W. P., Heat and Moisture Losses from Men at Work and Application to Air Conditioning Problems: Heating and Ventilating, vol. 28, No. 10, Oct., 1931, pp. 78-79.

1. This report contains data in the form of curves giving the rate of total heat loss, heat loss by radiation and convection, and heat loss by evaporation for men working at three constant rates in still air at various temperatures and two humidities. Corresponding curves for these losses with subjects seated at rest are also given.

2. Data for practical application and examples showing how it may be used in the solution of problems in air conditioning are presented.

3. A table showing the metabolic rate for different kinds of activity is given and the application to practical problems is shown.

4. Total energy production, energy loss, and heat loss are shown to be functions of effective temperature.

5. Sensible and latent heat loss are shown to be functions of dry-bulb temperature and only slightly affected by relative humidity except at extreme temperatures.

6. Sensible heat loss for men working increases but little over this loss for men at rest.

7. Latent heat loss increases rapidly with physical activity and is depended upon almost solely by the body for maintaining a constant body temperature with varying rates of heat production.

8. The comfort zone for men normally clothed and working at 33,075 ft.-lb. per hr. is given at 46° to 64° effective temperature and the comfort line as 53°.

9. The degree of perspiration experienced by men working at 33,075 ft.-lb. per hr. is given for various temperatures and humidities.

According to Humphreys:[86]

Many people who should know better seem to have surprisingly vague, if not even confused, ideas about humidity. Those who have to do with the measurement of humidity would insist, if questioned, that they know perfectly well what the terms "absolute humidity" and "relative humidity" properly mean. Perhaps they do; nevertheless many, if they should condescend to answer at all, would say, in substance, that absolute humidity is the mass of water vapor present per unit volume of the air, and relative humidity the ratio of the amount of water vapor present to the amount necessary to saturate the air at the same temperature.

86 Humphreys, W. J., (in Monthly Weather Review, July, 1931) A Common Humidity Error: Heating and Ventilating, vol. 28, No. 11, Nov., 1931, p. 52.

That sounds familiar and orthodox, but it reveals confusion at best, for the air has nothing to do with either absolute humidity, properly defined as the mass of water vapor per unit volume (of space, not air), or relative humidity--the ratio of the mass of water vapor present per unit volume (of space) to that which would saturate a unit volume at the same temperature. Be certain not to add "and same pressure," which we sometimes hear, for that refers to the atmosphere, which, as just stated, has nothing to do with the phenomenon in question.

There is, however, one very useful humidity concept that does involve the air, namely, the mass of water vapor per unit mass of humid air. This is called "specific humidity."

But entirely apart from definitions we often see and hear expressions about the air taking up water vapor and about the great avidity of warm air for water vapor. Now, as a matter of fact, the air does not "take up" water vapor--it is not a sponge; and warm air has no avidity, chemical or other kind, for water vapor. All the air does in this connection is to slow down the rate of evaporation and diffusion. It is not the air but the space, air or no air substantially alike (a shade better without the air), that has the vapor capacity. Neither is it the temperature of the air but the temperature of the vapor (again air or no air) that determines the amount of water vapor per unit volume necessary to produce saturation.

Most of us say the air takes up water vapor. Let us forget it, if we can, and say space instead, as that is what we mean, if we understand the phenomenon aright.

Weeks[87] describes a new instrument, the "coolometer," for measuring the cooling power of the environment. Its essentials are a copper spool covered with a copper shell, the spool being wound with heating coils which constitute also an electrical thermometer operating on the null principle to hold the desired temperature. The current input when the desired temperature is reached gives the rate of cooling, when combined properly with the constants of the instrument. The instrument can be operated as a reflecting or a black body, and thus can be used to study radiation. With the reflecting surface it can be used as an anemometer. Its construction is such that recording devices can be applied. It can be operated dry, or covered with a wet wick.

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87 - Weeks, W. S., A New Instrument for Measuring Cooling Power. The Coolometer: Jour. Ind. Hygiene, vol. 13, No. 7, Sept., 1931, pp. 261-265.

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United States Bureau of Mines
Scott Turner, Director

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GEOPHYSICAL ABSTRACTS

NO. XXXIX

BY

F. W. Lee

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No. 39

Compiled by Frederick W. Lee[2]

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1. GRAVITATIONAL METHODS

(841) ÜBER NORDDEUTSCHE SALZSTÖCKE, IHRE GENESIS UND TEKTONIK; BEZIEHUNGEN ZWISCHEN DER FORM UND DEM GRADIENTENBILD DER DREHWAAGENMESSUNG

(CONCERNING THE NORTH-GERMAN SALT-DOMES, THEIR GENESIS AND STRUCTURE; RELATIONS BETWEEN THE FORM AND THE GRADIENT PICTURE OBTAINED BY TORSION BALANCE MEASUREMENTS)

By Dr. Krusch

Kali, Halle (Saale), vol. 26, No. 5, 1932, pp. 51-56.

A discussion of the formation of salt domes in northern Germany is given in the first part of this article.

The importance of their discovery not only for the establishment of oil-bearing regions but also for the determination of tectonic lines and systems in the subsoil is mentioned. About 70 salt domes were discovered in north Germany.

The second part of the article deals with geophysical methods of prospecting for oil, especially with torsion balance measurements, by the interpretation of which typical forms of salt domes may be determined with a sufficient accuracy necessary for starting the boring tests. A few examples of these typical forms are examined.

From his observations carried out by torsion balance the author draws the conclusion that the gradient directions which often can not be explained must not be assigned to incidental causes, but must be completed by additional measurements until a geologically reasonable picture is obtained.--W. Ayvazoglou.

(842) NEW PENDULUM FOR PROSPECTING

Editorial note

The Petroleum World, London, vol. 29, No. 378, 1932, p. 92.

The attention of prospectors attracted by a device produced in the Paris Academy of Sciences, which may well prove useful in oil prospecting, is mentioned.

The apparatus, designed by M. Holweck and M. Lejay, is a new elastic pendulum for the measurement of gravity. The pendulum consists of a vertical rod about 4 inches long, terminating at its lower end in an elastic blade set in a fixed base. The elasticity of the spring is so calculated as to give an oscillation duration of about one second. The measurement, with an approximation of 1/10 second of the duration of about 1,000 oscillations, records gravity with a precision of two parts in a million.

To deal with errors resulting from friction, temperature, etc., required the use of distinct kinds of materials: The oscillating rod is of cast quartz, which lengthens by less than 1/1000 of a millimeter when temperature rises by 30° C.; the spring is made of elinvar, a metal the elasticity ratio of which is almost invariable with temperature; the pendulum is inclosed in a glass bulb welded to a ferro-chrome cylinder in which there is a high vacuum. The damping of oscillations is thus so reduced that the amplitude, after 900 oscillations, is still 33 per cent of its original value. The pendulum is observed through refraction prisms and reflecting microscope. For the measurement of time, a pocket chronometer with the usual double overlapping second hand is sufficient.

The process has been checked by measurements along the Paris-Corsica route and back, operations in Paris after the trip giving exactly the same results as on departure.--W. Ayvazoglou.

(843) DREHWAGE-MESSUNGEN AN DER AMERIKANISCHEN GOLFKÜSTE UND IHRE GEOLOGISCHE BEDEUTUNG

(TORSION BALANCE MEASUREMENTS ON THE AMERICAN GULF COAST AND THEIR GEOLOGIC IMPORTANCE)

By Walter Kauenhowen

Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin, vol. 83, No. 10, 1931, p. 731.

Below is given a translation of Kauenhowen's abstract from a paper presented at the meeting of the German Geologic Society held in November, 1931, concerning torsion balance measurements carried out under the direction of the author from 1928 to 1931 in the southern States of the United States:

Schweydar's torsion balances with photographic registration were used for the measurements. The instruments answered entirely the requirements of field service with regard to their sensitivity and construction. The execution and organization of the work was explained and illustrated by photographs; the results of the investigations of a series of various tectonic disturbances were discussed.

The following examples were illustrated by gravity pictures and geological profiles: Synclines, anticlines, soles, faults, grabens, salt domes, and magmatic intrusions. Among other results the southern boundary of the East Texas oil field, the largest in the world at the present time, was determined by gravimetrical method. The influence of these various disturbances upon the gradient, curvature value, and isograms was explained and the importance of the results of measurements for the oil geology was stressed.--W. Ayvazoglou.

(844) RELATIVE SCHWEREMESSUNGEN IN ERDÖLGEBIETEN

(RELATIVE GRAVITY MEASUREMENTS IN OIL-BEARING REGIONS)

By H. Gornik

Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin, vol. 83, No. 9, 1931, p. 666.

A lecture on the relative gravity measurements in oil-bearing regions was delivered by Gornik before the German Geological Society in September, 1931.

The following questions were discussed: The difference in importance for practical geologic purposes of gradient measurements carried out by the torsion balance on the one hand, and of determinations of relative gravity values carried out by the Sterneck pendulum on the other hand.

The principle of pendulum measurements and the simplified formula for the difference of the gravity values at two different stations. The necessary reductions of values determined by measurements. The importance of the reductions as based on examples from the practice. Results of pendulum measurements carried out in various regions in Germany (106 stations, 6,300 square kilometers), Egypt (12 stations, 200 square kilometers), Oklahoma (392 stations, 11,000 square kilometers), and Texas (89 stations, 40,000 square kilometers). Description of the original Sterneck apparatus and of an apparatus with photographic registration and wireless connection between the central station and field station as developed during the last years.

The importance for the German oil industry of pendulum measurements for the determination of the tectonic large structures of the north German lowland and of the structures between the salt domes. Review of pendulum stations in the whole world since 1808, about 4,800 stations in total, 600 of which belong to the Seismos Co., Hannover, and are situated in the oil-bearing regions.-- Author's abstract translated by W. Ayvazoglou.

(845) ON THE STRESSES IN THE EARTH'S CRUST REQUIRED TO SUPPORT SURFACE INEQUALITIES

By Harold Jeffreys

Monthly Notices of the Royal Astronomical Society, London, Geophysical Supplement, vol. 3, No. 1, January, 1932, pp. 30-41.

The maximum stress difference found in Darwin's problem below a surface elevation of the form a cos kx, was 0.736 $g\delta a$, where δ is the density of the uppermost rocks. It has been found that if there is no restriction on the vertical distribution of strength, it is possible to support a similar elevation with stress differences nowhere exceeding about 0.68 $g\delta a$. The stress

differences are distributed through a greater range of depth than on Darwin's theory, and attain their maximum at three different places, one of which is at the outer surface below the greatest elevations and depressions. This makes it possible to understand how fractures can extend up to the free surface, where, on Darwin's theory, there is no stress difference.

The stresses in a crust of variable thickness, resting on a denser material devoid of strength, are also considered. The stress difference in the crust can in these conditions be made nowhere greater than $g \rho a$, but such a distribution can not be improved. It requires that the mass per unit area down to a given surface in the lower layer, parallel with the spheroid (not the geoid) shall be constant, and is therefore consistent with Airy-Heiskanen isostasy. There is a disturbance of gravity in the lower layer, so that the equipotentials immediately below the interface are not strictly spheroidal. The support of inequalities in any other conditions will require greater stress differences in the lithosphere. In the most favorable case there is no vertical stress across vertical planes, so that the crust may be considered as if made of blocks floating independently.

It appears that minimum estimates of strength already made from the height of visible inequalities and the variation of gravity at geoid level are still approximately correct.

The elastic stresses in a floating crust due to disturbance of the outer surface by denudation or deposition over areas much wider than the depth of the crust are known to be much greater than $g \rho$ times the additional elevation or depression. The development of such features will take place in three stages. In the first, so long as the disturbance is not too great, the stress differences in the asthenosphere will not exceed its strength, and Darwin's theory, or the modifications referred to in this article, will apply. In the second the disturbance becomes great enough to produce yield in the asthenosphere and the stress differences in the lithosphere are accordingly increased to those appropriate to elastic yield in a floating crust. In the third the stress differences in the crust itself come to exceed its strength, and yield in the crust keeps pace with deposition or denudation, so that $g \rho a$ never exceeds the strength of the material.--Author's abstract.

(846) THE HYPOTHESIS OF ISOSTASY

By J. de Graaf Hunter

Monthly Notices of the Royal Astronomical Society, London, Geophysical Supplement, vol. 3, No. 1, January, 1932, pp. 42-51.

The following conclusions regarding the Hayford hypothesis of isostasy are drawn from the article:

1. The Himalayan regions so far explored gravitationally exhibit gravity anomalies which are greatly reduced by the hypothesis, and indicate an average of 90 per cent compensation. The average departure from Hayford compensation may be represented by an equivalent stratum 864 feet thick of ordinary surface rock (density 2.67) in excess.

This is strong support for the hypothesis of mountain compensation in accordance with Pratt and Hayford.

2. (a) Strong support for Hayford's hypothesis has been found in the United States over an area 0.9 per cent of the surface of the globe.

(b) Large departures from Hayford's hypothesis, numerically equivalent to over 1,000 feet of surface rock, have been found to characterize continental India, over an area of 0.5 per cent of the surface of the globe.

(c) Very large departures from Hayford's hypothesis have been found in the vicinity of the Dutch East Indies. A large systematic negative anomaly exists over an area of 0.25 per cent of the surface of the globe. The magnitude of this anomaly appears to average at least 0.100 cm. $sec.^{-2}$, and is equivalent to a thickness of 2,980 -- say 3,000 feet of rock of density 2.67.

The areas dealt with are small considered as percentages of the earth's surface; they represent, however, most of the available evidence. They show that:

0.9 per cent of the surface strongly supports Hayford's hypothesis.
0.75 per cent of the surface strongly denies the hypothesis.

The fair conclusion seems to be that regions exist where the hypothesis closely resembles facts, but that regions also exist where precisely the reverse is the case. With less than 2 per cent of the earth's surface gravitationally explored, it is useless to conjecture what proportion of the earth accords with the hypothesis. There is no "principle of isostasy" in the sense that has often been implied, that is, of Hayford compensation; and it is misleading to use this term. We can not presume that Hayford compensation has actuality in any region unless we find by measurement that it has. We certainly can not compute the form of the geoid by assuming Hayford compensation, with any chance of success.

On the other hand, we can use the concept of Hayford compensation as an ideal standard, with reference to which gravity anomalies may be stated. In so doing we gain distinct computational advantages. Our anomalies will thereby very probably be freed of the disturbing effects of mountain ranges, etc., at great and medium distances; and even if on occasion this is not the case, no harm is done. We shall know what our standard of reference is, as this is quite definitely defined, just as the size and location of our reference spheroid is defined.

There may well be a "principle of isostasy" in the vaguer sense in which Dutton introduced the word isostasy. I think this could almost be expressed by changing the old expression "water finds its own level" into "the earth's crust finds its own level." Surely it is merely a mechanical concept that the natural tendency of the material of the crust is to adjust itself toward hydrodynamical equilibrium, to which it may approximate more and more with lapse of time, but which it will never absolutely attain owing to the resistive strength of the materials of the crust. One would, indeed, be surprised if the ordinary laws of mechanics and of strength of materials were suspended in the earth's crust.

But it is the artificial, though useful, and restricted sense of Hayford compensation, in which the compensating densities are for convenience arranged in vertical columns of uniform density anomaly, that the term "isostasy" has come to mean, and the "principle of isostasy" accordingly implies the existence of Hayford isostasy over the whole earth -- which is in opposition to the observed facts.--Author's abstract.

(847) NOUVEAU MODÈLE DE PENDULE HOLWECK-LEJAY. VALEUR DE LA GRAVITÉ EN QUELQUES POINTS DE LA FRANCE CONTINENTALE ET EN CORSE

(A NEW MODEL OF HOLWECK-LEJAY PENDULUM. GRAVITY VALUES AT SEVERAL PLACES IN FRANCE AND IN CORSICA)

By F. Holweck

Comptes Rendus de l'Académie des Sciences, Paris, vol. 193, No. 26, 1932, pp. 1399-1401.

Improvements made in the new model of the Holweck-Lejay pendulum by which its sensitivity was greatly increased are enumerated. Two series of six measurements each were made in the observatory in Paris in order to prove the sensitivity of the new apparatus. Besides, field measurements were carried out in August and September, 1931, with the same purpose. A table showing the values of "G" observed at a series of stations between Paris and Corsica is given. After returning to Paris the first measurement taken in Paris before the departure was checked and in both cases the same value was obtained.--W. Ayvazoglou.

2. MAGNETIC METHODS

(848) ON THE DETERMINATION OF THE HORIZONTAL COMPONENT OF THE EARTH'S MAGNETIC FIELD BY A COUPLED OSCILLATIONS METHOD

By L. G. Vedy

Proceedings of the Cambridge Philosophical Society, vol. 28, Part 1, 1932, pp. 109-114.

An account is given of a simple experiment designed to illustrate quantitatively the phenomena of coupled oscillations. Two similar small magnets are suspended in the earth's magnetic field at a suitable distance apart so that there is appreciable magnetic interaction between the two oscillatory systems. Under the conditions employed, the equations of motion reduce to a simple form, and the experiment may be used as a method of measuring the intensity of the horizontal component of the earth's magnetic field.--Author's abstract.

(849) ÜBER MAGNETISCHE STÖRUNGEN DIE AN SÜDNORWEGISCHEN NORDLICHTTAGEN IN POTSDAM BEOBACHTET WURDEN

(ON MAGNETIC DISTURBANCES WHICH WERE OBSERVED IN POTSDAM DURING THE AURORA BOREALIS DAYS IN SOUTH NORWAY)

By A. Röstad

Geophysical Publication, Oslo, vol. 9, No. 3, 1931, 30 pp.

In this paper the author presents the results of a statistical study of magnetic disturbances. The work is divided into two parts: (a) Relation between the aurora and magnetic disturbances, and (b) special characteristics of magnetic disturbances.

The auroral data consisted of measurements of the angle Θ published by Störmer for auroral observation in southern Norway during 1911-22, Θ being the angle between the earth's magnetic axis and some prominent point in the aurora as seen from the center of the earth. The magnetic disturbing forces were computed from the records of Potsdam and Tucson. The curves representing the relation between Θ and the intensity of magnetic disturbance show naturally an increase in Θ with increase in magnetic activity, but for Potsdam the curve is rectilinear whatever the type of aurora (rays, arcs, or diffused arcs), while for Tucson the curve is of a parabolic type. The author believes that this was to be expected from theoretical considerations.

For the study of special characteristics of magnetic disturbances, hourly values of the disturbing force P were computed for 144 disturbed days between 1891 and 1922. The force P is referred to three rectangular axes with origin at the point of observation, one axis being parallel to the earth's magnetic axis, the second perpendicular to the magnetic axis, and the third perpendicular

to the other two. The components of P along these axes are respectively P_a, P_r, and P_c. The 144 disturbed days are divided into seven groups according to intensity of disturbance. With these data a variety of investigations are carried out: Namely, diurnal-variation curves of P are developed for different intensity groups, also diurnal-variation curves of P_a/P, P_r/P, and P_c/P, diagrams showing momentary frequency distributions of direction of disturbing force, diagrams showing diurnal variations of the projections of the angle $\cos^{-1} P_a/P$ (Θ and ψ) on the two vertical coordinate planes, curves representing the relation between Θ and P_a, and finally curves resulting from a study of irregular short-period fluctuations. The author contributes a full and interesting discussion of the diagrams, pointing out their noteworthy features and attempting to discover their physical meanings.--W. F. Wallis' abstract reprinted from the Terrestrial Magnetism and Atmospheric Electricity, Baltimore, vol. 37, No. 1, 1932, p. 92.

(850) ERGEBNISSE REGIONAL-MAGNETISCHER FORSCHUNG IN DER EIFEL

(RESULTS OF THE REGIONAL MAGNETIC INVESTIGATIONS IN THE EIFEL)

By H. Reich

Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin, vol. 83, No. 9, 1931, pp. 646-653.

Measurements carried out at the first-class stations had shown unusually great change in the difference of the vertical intensity between Potsdam and the Rhineland. The isodynamic lines of the vertical intensity suffered great warpings during the last 30 years which probably were caused by deep magnetic processes.

The regional surveys in the region of the Neuwieder basin resulted in finding positive anomalies in SSW-NNE direction in the western part of the basin; these anomalies followed about the axis of the Siegen layers. The west parts of the Eifel Valley and the southeast parts of the region of the Hunsrück slates were marked by negative anomalies.

An unusually strong magnetic disturbance was established in the Hohen Venn in the region to the west and north of Monschau. The form and extension of this anomaly makes it possible to draw a conclusion that this anomaly is probably caused by the influence of a magnetic edge-face of Plutonic granite (Lammersdorf-granite).--Author's abstract translated by W. Ayvazoglou.

(851) ERGEBNISSE ERDMAGNETISCHER UNTERSUCHUNGEN IM VULKANGEBIET DES LAACHER SEES IN DER EIFEL

(RESULTS OF EARTHMAGNETIC INVESTIGATIONS IN THE VOLCANIC REGION OF LAKE LAACH IN THE EIFEL)

By W. Ahrens

Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin, vol. 83, No. 9, 1931, p. 667.

The purpose of these measurements consisted of determining the distribution of the basaltic lava streams, the extension of which below the thick

overburden of trachytic tuffs could not be established in other ways. It was proved that this was possible even in the region with the most thick tuff overburden (more than 30 meters). Difficulties in following the direction of the lava streams were probably caused by the interruption of the streams; the explanation of these interruptions was possible only in single cases. On the other hand, some peculiarities in the structure of the streams could be disclosed by diagrams. Extraordinary strong anomalies were produced by basaltic slag masses, that is, by volcanic matter (Vulkanbauten) from which the lava streams originated; these anomalies were greater than those above the lava streams (sometimes to 6,000 γ).

Besides, it was established, to the contrary of measurements made in other regions (for example, schalstein in the Lahn-Dill region), that some tuffs, basaltic as well as trachytic, as long as they contain sufficient amounts of magnetic iron and are of corresponding magnitude, produce very great disturbance values, sometimes of about 1,000 γ, in places where the rocks appeared in the form of mountain tops.--Author's abstract translated by W. Ayvazoglou.

(852) INTERPRÉTATION GÉOLOGIQUE DE MESURES MAGNÉTIQUES DANS LE BASSIN DE PARIS

(GEOLOGICAL INTERPRETATION OF MAGNETIC MEASUREMENTS IN THE BASIN OF PARIS)

By J. P. Rothé

Comptes Rendus de l'Académie des Sciences, Paris, vol. 191, No. 23, 1930, pp. 1144-1146.

The purpose of the work carried out by Rothé consisted of showing how an anticline perfectly determined by geological survey can be interpreted magnetically. Two places were investigated.

1. The anticline of Bray County. Isolines were drawn based on profiles obtained from magnetic survey. According to the interpretation of the results it was shown that the presence of the geologic anomaly could be proved only in places where ferruginous sands and sandstones were outcropping. The magnetic anomaly disappeared with the disappearance of these guiding deposits.

2. Magnetic anomaly in the basin of Paris. Numerous measurements with the vertical variometer were carried out by the author in the region of Rambouillet-Houdan in order to determine exactly the form of the anomaly discussed and studied by Moureaux. According to the results the values of the anomaly obtained were smaller than those given by Moureaux. In comparing the results of magnetic surveys carried out in 1896-1904 and in 1924 the differences could not be assigned to hazard, as the region where the decrease was the highest was just that with the maximum anomaly.

Based on the results obtained it was shown that there was no relationship between the anomaly and the folds of the overburden in the basin of Paris.--W. Ayvazoglou.

(853) BERÄKNING AV MAGNETISKA MALMERS DJUPGÅEDE

(CALCULATION OF THE DEPTH OF FERROMAGNETIC ORES)

By Th. Dahlblom

Jernkontorets Annaler, Stockholm, vol. 115, No. 2, 1931, pp. 95-102.

One of the poles of an ore magnet appears always to be situated close to the deepest point of the orebody, irrespective of the relation of dip and strike to the magnetic field of the earth. If the position of the lower pole can be determined, the approximate depth of the ore is consequently known. At a sufficient distance from the ore, the magnetic field may be considered to be approximately equal to that of an ideal magnet, and the author describes several methods by which the poles of the ore magnet may be found through measuring the direction of the field at different points on the surface. The best results are obtained by using curves drawn through points where the angle between the direction of the magnetic field and the axis of the magnet has the same value.--Author's abstract.

3. SEISMIC METHODS

(854) CONSTRUCTION OF MASTER MECHANICAL OSCILLATOR FOR TESTING SEISMIC RECORDERS AND OTHER ALLIED APPARATUS

By F. W. Lee and G. A. Irland

U. S. Department of Commerce, Bureau of Mines, Washington, D. C., Technical Paper 518, 1932, 17 pp.

Contents of the article:

1. Introduction.
2. Acknowledgments.
3. Specifications.
4. Scale of measurement.
5. Construction.
6. Principle of operation.
7. Electrical measurement of vibrational displacement.
8. Oscillator recorder.
9. Materials for constructing oscillator recorder.
10. Optical measuring system.
11. Method of manipulation.
12. Measurement of constants of vibrator.
13. Measurement of constants.
14. Tabulation of constants of master vibrator.
15. Discussion and results.

Appendix. Elementary mathematical relations controlling vibration of table.

Fifteen illustrations are added to the article.

The article contains investigations carried out by the authors for studying mechanical vibrations from the viewpoint of seismic exploration as well as from the limit of strength a structure may offer to blasting operations.

The necessity to have available a suitable master oscillator or vibrator with which to calibrate the field apparatus is dictated by the fact that seismograms, before they can be used to contribute real information concerning geophysics and the nature of vibrations, should be expressed in some absolute system of measurement. Records of different instruments at different stations should be directly comparable. It is therefore necessary to recheck or calibrate at various intervals these instruments to ascertain if they have retained their accuracy of calibration.

Concluding the last item "Discussion and results," the authors say:

> Mechanical systems free from linkages having vibrational rigidity are especially well suited for mathematical analysis of this nature. That building structures, units, etc., should fall into this class is purely coincidence. It is suggested that the c.g.s. system, on account of its intrinsic simplicity, be adopted in describing these relations and that the mechanical definitions which arise have a nomenclature similar to that used at present in the electrical science.
>
> From the relation
>
> $$A = \frac{\frac{F}{\omega}}{\frac{K}{\omega} - M\omega + jr} = \frac{\text{Force per unit angular velocity}}{\frac{K}{\omega} - M\omega + jr}$$
>
> the system may be reduced to one of linear fractional transformation of the straight line $\frac{K}{\omega} - M\omega + jr$ into a circle having a diameter $\frac{1}{r}$, allowing a simple graphical visualization of the amplitudes and phase relationship, the variable parameter being the angular velocity of frequency when the factor $\frac{F}{\omega}$ is held constant.--W. Ayvazoglou.

(855) A SMOOTHING DEVICE APPLIED TO THE NEW SEISMOLOGICAL TABLES

By L. J. Comrie and Harold Jeffreys

Monthly Notices of the Royal Astronomical Society, London, Geophysical Supplement, vol. 3, No. 1, January, 1932, pp. 10-13.

The revised tables of transmission times of P and S, recently given by Jeffreys (Geophys. Abs. 32, p. 313), were provisional in the sense that there was some outstanding uncertainty about their behavior near 20°; this uncertainty has been considerably reduced (Geophys. Abs. 36, p. 420) by showing that the formulas used up to 17.5° required to have their cube terms doubled. Beyond 20° the times were empirical, except that small corrections had been

applied at a few distances to satisfy the theoretical condition that the second differences must always be negative. But there were still irregularities outstanding, and there was a doubt as to the mode of transition between 20° and 30°. Attempts have been made to remove these, but have been given up on account of the danger of introducing systematic error. A method of smoothing devised during the preparation of the tables for interpolation appears to remove these difficulties. It rests on the principle that the second differences are to vary as smoothly as possible.

This device has been applied in the present paper. The method is exhibited in two tables. The final results are shown in a table.

The authors conclude, however, "That if there are real differences between different earthquakes these will have been hidden by the process of averaging. Systematic differences of the order of 5s may be expected between the travel times of continental and oceanic earthquakes, on account of the difference in the structure of the upper layers. The detection and elucidation of these must await further enquiry."--W. Ayvazoglou.

(856) THE DETERMINATION OF THICKNESSES OF THE CONTINENTAL LAYERS FROM THE TRAVEL TIMES OF SEISMIC WAVES

By A. W. Lee

Monthly Notices of the Royal Astronomical Society, London, Geophysical Supplement, vol. 3, No. 1, January, 1932, pp. 10-13.

A novel method is given for analysis of the connection between time of origin of an earthquake, the depth of focus, apparent times of starting of the seismic waves, and the thicknesses of the layers through which they travel.

Application of the method to the available data for an earthquake near Imotski, Yugoslavia, on 1923 March 15, shows that the focus was near the bottom of the granitic layer. The approximate thicknesses of the layers are determined as 1 kilometer of sedimentary material, 11.5 kilometers of granite, and between 22 and 33 kilometers of intermediate rock.

The travel times of the waves from the shocks in Jersey on July 30, 1926, and in Herefordshire on August 15, 1926, indicate that the thicknesses of the granitic and basaltic layers were 14 and 15 kilometers, and that the foci were 10 and 6 kilometers respectively below the top of the granite.--Author's abstract.

(857) THE NORTH SEA EARTHQUAKE OF 1927, JANUARY 24

By A. W. Lee

Monthly Notices of the Royal Astronomical Society, London, Geophysical Supplement, vol. 3, No. 1, January, 1932, pp. 21-30.

Contents:

1. Introduction.
2. Data.
3. Determination of epicenter.
4. The normal P and S waves.
5. Other waves.
6. Depth of focus and time of origin.

Author's summary reads as follows:

Data given in the International Seismological Summary for the North Sea earthquake of January 24, 1927, have been supplemented by measurements of the original seismograms for Dyce, Edinburgh, Stonyhurst, Copenhagen and Kew, for determination of the epicenter and study of the phases recorded. The epicenter is located as $59^o.4$ N., $2^o.9$ E., with time of origin $5^h\ 18^m\ 11^s$.

Times of transmission for the P and S phases may be represented closely by the formulas:

$$T_p = 5^h\ 18^m\ 22^s + 14.21\Delta - 2.00\ (\Delta/10)^3$$
$$T_S = 5^h\ 18^m\ 17^s + 25.50\Delta - 3.50\ (\Delta/10)^3$$

A number of measurements indicate other waves with velocities 7.0 km./sec. (P_Q), 4.0 km./sec. (S_Q) and 3.6 km./sec. (S*).

The focus was situated near the bottom of the granitic layer.--W. Ayvazoglou.

(858) OUR PRESENT KNOWLEDGE CONCERNING THE INTERIOR OF THE EARTH

By James B. Macelwane

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 21, No. 4, 1931, pp. 243-250.

This paper was presented at a meeting of the Eastern Section of the Seismological Society of America, June 11 and 12, 1931. The author started the discussion on the structure of the earth with Mohorovicic's account of the Kulpa Valley earthquake of October 8, 1909, in southern Europe, in which the latter found it necessary to postulate two layers in the structure of the earth's crust in order to account for the successive impulses he observed in the first phase. The discussion on the development of the knowledge concerning the interior of the earth was then continued based on the extensive literature published on this question. A list of references mentioned by the author during the discussion is added to the article.--W. Ayvazoglou.

(859) FILLING THE GAPS IN THE SEISMOLOGICAL PROGRAM

By N. H. Heck

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 21, No. 4, 1931, pp. 261-267.

In the first part of this article Heck enumerates the seismological stations installed in the Caribbean region as a whole and says that although all these stations are important in connection with the study of this region it is necessary that other high-grade stations be added either by the replacement of instruments at existing stations or by the establishment of new ones.

The main part of this article deals with the seismological problems of the continental United States. In examining the instrumental situation the author points out a number of important gaps yet to be filled.

Some problems to be solved are discussed, such as: The number of stations required, types of instruments to be selected, need for a limited number of vertical-component seismometers at selected stations, the very serious question of providing the stations with trained personnel, developing entirely new types of instruments, etc.

The author concludes that although we may feel greatly encouraged at the progress that has been made, a determined effort must be made to fill the gaps in the program that have been described, as well as others that may exist or that may develop.--W. Ayvazoglou.

(860) MODIFIED MERCALLI INTENSITY SCALE OF 1931

By Harry O. Wood and Frank Neumann

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 21, No. 4, 1932, pp. 277-283.

The formation of a satisfactory earthquake intensity scale has long been a subject for consideration and discussion among those who are interested actively in studies of shock intensity and its geographic manifestation.

The Rossi-Forel scale which has been in wide use for many years has become inadequate for present-day needs.

The scale proposed here by the authors is a modification and condensation of the Mercalli-Cancani scale as formulated by Sieberg (A. Sieberg, "Erdbebenkunde", pp. 102-104, Jena, 1923), worked out at the Seismological Laboratory in Pasadena, Calif. The scale presented in this article has been accepted, after some changes and additions, by organizations and individuals in the United States active in seismological work. The U. S. Coast and Geodetic Survey will use it in the publication of its seismological results for 1931.--W. Ayvazoglou.

(861) ACCURATE RECORDS OF STRONG EARTHQUAKE MOTIONS

By N. H. Heck

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 21, No. 4, 1931, pp. 285-288.

Although a number of institutions and organizations, as well as the National Government, have included in their program the observation of distant earthquakes and of light to moderate near-earthquakes, and also the collection of reports of visible and felt effects of strong earthquakes, nothing has been done, according to the author, in the precise instrumental measurement of strong earthquake motions, especially in the cases in which damage has occurred.

In this article the author outlines a number of principles which have been developed by him through study of the problems and through conferences in order that the situation may be understood.--W. Ayvazoglou.

(862) THE P CURVE AND THE S CURVE RESULTING FROM A STUDY OF THE TANGO EARTHQUAKE, JAPAN, MARCH 7, 1927

By Ernest A. Hodgson

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 22, No. 1, 1932, pp. 38-49.

The records of the Tango earthquake, for which the coordinates of the epicenter and the origin time are well defined and whose focus is shallow, furnish data which define the P curve with considerable precision to an epicentral distance of about 8°. From that point to 50° the curve is fixed in position by very few points. The values given by Byerly for the Montana earthquake have influenced the author in placing the curve as reported for this range. Such a placing is demanded also, to some extent, by the earlier and the later parts of the curve. As so placed, it lies considerably below the Mohorovicic-Macelwane P curve for much of the range; the maximum difference being about nine seconds. It is certain that the latter curve gives P-O intervals much too great near the center of this range, but it would be desirable to make a detailed study of some other earthquake whose epicentral position, origin time, and depth of focus could be well defined and for which the last named would be shallow, the earthquake being so situated that well-equipped stations would register the disturbance for distances within this range.

From 50° to 60° the control is better, but there are still too few points to fix its position as definitely as could be desired. From 60° to 100° there are many control points of considerable strength. This section of the P curve seems fixed in position within narrow limits. Data for distances beyond 101° are lacking.

Footnotes to the tabulations for both the P curve and the S curve are given in some detail as showing the relative strength of controlling points.

In the case of the S curve, there seems to be no well-defined departure from the curve published in mimeographed form by Macelwane in 1926. The footnotes explain outstanding departures from this curve. It may be said that the Tango earthquake data support the previously published S curve to within the limits of accuracy of the observations.--Author's abstract.

(863) RICHMOND QUARRY BLAST OF SEPTEMBER 12, 1931, AND THE SURFACE LAYERING OF THE EARTH IN THE REGION OF BERKELEY

By Perry Byerly and Karl Dyk

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 22, No. 1, 1932, pp. 50-55.

The authors describe in this article the results of a quarry blast carried out near Castro Point, Richmond. To place the charge a horizontal shaft 63 feet long, 5 feet wide, and 4 feet high was dug into the base of the 300-foot cliff face. At its end was driven a cross shaft, 163 feet in length, along which the charge of 32.5 tons of 10 per cent Judson blasting powder was placed. It was estimated that 300,000 tons of rock were loosened. The resulting earth shock was recorded at Berkeley on the two Wood-Anderson seismographs.

The interpretation of the records is given. The various arrivals of the waves are shown in a figure. Speeds of 4.44 kilometers per second for the P wave and 2.37 kilometers per second for the S wave were established. The ratio of speeds for P and S is thus 1.87, which indicates that Poisson's ratio for this medium is 0.3. This value is not inconsistent with that given by Nagaoka for sandstones. P and S also were recorded which had speeds of 5.6 and 3.1 respectively. These are recognized values for granite. It is therefore concluded that granitic rocks underlie this region and that these waves have penetrated into it for part of their paths.--W. Ayvazoglou.

(864) TESTING OF PHOTOGRAPHIC RECORDERS

By H. E. McComb

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 22, No. 1, 1932, pp. 56-59.

The operation of the optical system used in the tests is described as follows: A straight-filament galvanometer lamp is mounted about 1 meter from the face of the recording drum to be tested. The filament of the lamp is adjusted so that it is parallel to the axis of the drum and to the axis of a short-focus cylindrical lens mounted just in front of the lamp. The light

which passes through this lens is brought to focus on the face of the drum and forms an enlarged image of the lamp filament. The cylindrical lens of the recorder is then interposed in its regular position and the rays brought down to a very fine line. The light is flashed at regular intervals by means of a shutter operated by a break-circuit chronometer.

Sections of two of the records made with two different recorders are shown in two figures.--W. Ayvazoglou.

(865) DEVELOPMENT OF SEISMOLOGICAL INSTRUMENTS AT THE BUREAU OF STANDARDS

By Frank Wenner

Bulletin of the Seismological Society of America, Stanford University, Calif., vol. 22, No. 1, 1932, pp. 60-67.

In this article Wenner describes the construction of an accelerometer assigned for use within the destructive area of major earthquakes. This instrument may be adjusted to, and it is expected that it will be used with, a period of one-tenth of a second or possibly somewhat less.

A photograph of the accelerometer is given.--W. Ayvazoglou.

(866) A PORTABLE SEISMOGRAPH FOR RECORDING ARTIFICIAL EARTHQUAKES

By J. H. Jones and D. T. Jones

Journal of Scientific Instruments, London, vol. 9, No. 1, 1932, pp. 8-17.

A portable seismograph for recording artificial earthquakes is described. The motion of the pendulum is magnified by means of an arrangement of two small magnets and a soft iron element suspended on a phosphor-bronze strip which is attached to the pendulum.

The coupling of the magnifying system to the pendulum introduces a couple which opposes the restoring moment of the pendulum and lengthens the periodic time of the seismograph. Other important features of the instrument are the absence of friction from the magnification linkage and simple methods for the remote control of the "zero," the period, and the sensitivity. An experimental investigation of the relation between the period and sensitivity is described.

The instrument has been thoroughly tested, under difficult field conditions, by the geophysical staff of the Anglo-Persian Oil Co. (Ltd.), during seismic surveys in the oil fields of southwest Persia.

Three typical seismograms obtained with the instrument are shown.

Contents:

1. Introduction.
2. Description of the instrument: (a) The pendulum; (b) the magnetic method of magnifying the pendulum motion; (c) remote control of zero position; (d) remote control of the period and sensitivity; (e) the damping of the free movement of the element and pendulum.
3. Theoretical considerations: (a) Condition for maximum pendulum magnification; (b) effect of the size of the cone on the magnification.
4. Experimental investigation of the sensitivity and period of the seismograph: (a) The magnification of the pendulum; (b) the magnification due to the magnet system; (c) the effect of the magnet system on the period of the pendulum; (d) the effect of varying the tension of the suspension.
5. Test of seismograph in the field.--W. Ayvazoglou.

(867) SISMOGRAPHE ENREGISTREUR ASKANIA À TROIS COMPOSANTES, DESTINÉ À LA MESURE DES VIBRATIONS DES CONSTRUCTIONS

(ASKANIA THREE-COMPONENT RECORDING SEISMOGRAPH ASSIGNED FOR MEASURING THE VIBRATIONS OF BUILDINGS).

Editorial note

Le Génie Civil, Paris, vol. 100, No. 8, 1932, pp. 193-195.

The description of the Askania 3-component recording apparatus based on Schweydar's principle is given in this article. The apparatus constructed in collaboration by Prof. Hort and Angenheister has been improved by Askania Works which reduced the defects of its construction to a minimum by introducing optical transmission and amplification of oscillations, as well as by proper choice of the relation between the levers and the dimensions of the oscillating systems. A longitudinal section of the seismograph and diagrams recorded on a Diesel motor are added.--W. Ayvazoglou.

(868) ÜBER OBERFLÄCHENWELLEN

(CONCERNING SURFACE WAVES)

By Tokunosuke Itoo

Gerlands Beiträge zur Geophysik, Leipzig, vol. 35, No. 3/4, 1932, pp. 349-356.

Mathematical discussion on the surface waves is given under the following headings:

1. Fundamental equations concerning surface waves.
2. Surface shearing waves.
3. Relationship between the absorption coefficients and viscoelastic coefficients.--W. Ayvazoglou.

4. ELECTRICAL METHODS

(869) ÜBER EIN GEOLEKTRISCHES SCHÜRFVERFAHREN ZUR INDIREKTEN BESTIMMUNG DER DECKEN- UND FLÖZMÄCHTIGKEIT

(ON A GEOELECTRICAL METHOD OF PROSPECTING FOR DETERMINING THE THICKNESS OF THE OVERBURDEN AND THE THICKNESS OF THE LAYER)

By W. Stern

Braunkohle, Halle (Saale), vol. 31, No. 9, 1932, pp. 149-152.

In this article the author gives a description of the physical foundations of a geoelectrical method of prospection, its operation and the apparatus used. The description is based on the results of the practical application of the method carried out during 1930 and 1931 in the lignite mines "Gruhlwerk and Beisselsgrube" of the "Rheinische Aktien-Gesellschaft für Braunkohlenbergbau und Brikettfabrikation."

The apparatus, a diagram showing schematically the method of connection used for measurements, as well as two resistance diagrams based on which the depth-profiles of the Gruhlwerk mine and Beissel mine were determined are given.--W. Ayvazoglou.

(870) EIN NEUER SCHULZESCHER ERDINDUKTOR

(A NEW SCHULZE'S EARTH INDUCTOR)

By R. Bock

Zeitschrift für Instrumentenkunde, Berlin, vol. 52, No. 2, 1932, pp. 85-86.

The article describes a new construction of the earth inductor, as designed by Schulze's precision measuring instrument shop and the author, by which some inconveniences in determining the magnetic inclination, especially by taking field measurements, are eliminated.

A photograph of the instrument is given.--W. Ayvazoglou.

(871) ELECTRICAL CORING BY THE DETERMINATION OF BOTTOM-HOLE DATA

By C. and M. Schlumberger and E. G. Leonardon

The Petroleum Times, London, vol. 27, Nos. 688 and 689, 1932, pp. 307-308 and 355-357.

This article is a summary of Technical Publication 462, 1932, 38 pp., issued by the American Institute of Mining and Metallurgical Engineers. An abstract of Technical Publication 462 is given in Geophysical Abstracts 35, p. 392.--W. Ayvazoglou.

(872) ELECTRICAL CORING: DETERMINING BOTTOM-HOLE DATA BY ELECTRICAL MEASUREMENTS

By C. and M. Schlumberger and E. G. Leonardon

The Petroleum World, London, vol. 29, Nos. 378 and 379, 1932, pp. 98-100 and 122-124.

This is an article published by the authors from a paper presented before the American Institute of Mining and Metallurgical Engineers in New York and issued as Technical Publication 462 in 1932. Authors' abstract of this publication is given in Geophysical Abstracts 35, p. 392.--W. Ayvazoglou.

(873) INSTRUMENT FOR MEASURING CORROSIVE PROPERTIES OF SOIL

By E. R. Shepard

The Oil Weekly, Houston, vol. 61, No. 11, 1931, p. 30.

As a result of the study of corrosion of underground pipes it was found that soils high in soluble salts, and therefore low in electrical resistivity, are usually highly corrosive to pipe lines. In this connection, Shepard developed an instrument for a simple and quick measurement of the electrical resistivity of soil.

In this article the description of the Shepard earth-resistivity meter is given. The meter consists mainly of two rods or canes tipped with iron electrodes; a flashlight battery and milliammeter are mounted in a light aluminum frame on one of the rods. The rods are pushed into the earth with a separation of about 1 foot or more, the circuit is closed, and the resistivity of the soil is read directly in ohm-centimeters on the scale of the instrument. The manner in which polarization has been overcome or minimized has been accomplished by making the cathode very much larger than the anode, as shown in the accompanying figure.--W. Ayvazoglou.

(874) DRILLING PROVES EXISTENCE OF METEORIC MASS

By C. H. Wilson

The Mining Journal, Phoenix, vol. 15, No. 23, 1932, p. 7.

A brief account of the geophysical examination of Meteor Crator and the results obtained was published by the Mining Journal of April 15, 1931 (see Geophys. Abs. 25, p. 127). In the present article information is given on the results of two drill holes completed by the Meteor Crator Exploration & Mining Co.

The existence of a mass of meteoric material at the depth and location indicated by the previous geophysical examination of the crater was proved.--W. Ayvazoglou.

5. RADIOACTIVE METHODS

(875) ZUM PROBLEM DER RANDSTÖRUNGEN BEI IONENMESSUNGEN

(CONCERNING THE PROBLEM OF EDGE-DISTURBANCES IN CARRYING OUT IRON MEASUREMENTS)

By H. Israel

Gerlands Beitrage zur Geophysik, Leipzig, vol. 35, No. 3/4, 1932, pp. 341-348.

Measurements of ions carried out according to the condenser method result in errors caused by the inhomogeneity of the electrical field at the ends of the condenser. These errors may be calculated if they are supposed to be caused by an hypothetical condenser with homogeneous field, joining directly the condenser. The "methods of charging and discharging" (Auflade-und Entlademethode) give different disturbances, the hypothetical condenser will also be different in both cases. Two constants of the disturbances a and i are given, allowing a correction of the measured number of ions and of their mobility for both methods; their reciprocal value represents a direct measurement of the magnitude of the disturbance. It is shown that the method of discharging is preferable for counting the ions, and the method of charging for measuring the mobility.--Author's abstract.

(876) DIE ELEKTRISCHEN ZÄHLER FÜR KORPUSKULARSTRAHLEN

(ELECTRIC COUNTERS FOR CORPUSCULAR RAYS)

By Georg Stetter

Verhandlungen der Deutschen Physikalischen Gesellschaft, vol. 12, No. 2, 1931, pp. 26-29.

In a lecture delivered at the meeting of the Austria association in Vienna held on June 8, 1931, the author discussed the methods of counting the corpuscular rays (Drahtenelektrometer, Röhrenelektrometer and Stossionisationszähler). Principles of operation and the limits of the effects produced by each instrument were compared.--W. Ayvazoglou.

6. GEOTHERMAL METHODS

(877) RELATION OF EARTH TEMPERATURES TO GEOLOGIC STRUCTURE

By John A. McCutchin

The Oil Weekly, Houston, vol. 65, No. 2, 1932, pp. 21-26.

The purpose of this research has been to determine the possibility of using temperature data for the location of future oil pools, particularly in areas where the generally used geological and geophysical methods meet with little success.

Detailed temperature surveys have been made by the author in over 300 wells located in 40 oil fields of Oklahoma and Kansas. While the relations in any field in these areas are practically the same, the relations of earth temperatures to geologic structure in the Dilworth field of Kay County, Okla., has been chosen to illustrate the possibilities of using earth temperatures to locate oil fields. A brief history of the study of earth temperatures and a description of method and apparatus are given. According to two parts of a plate added to the article, a marked relation between geologic structure and the present observed position of the isothermal surfaces in the south dome of the Dilworth field is shown.

The author concludes: "The results of the temperature observations made in the Dilworth field and in many other fields of Oklahoma and Kansas indicate that this problem has commercial possibilities as a new geophysical method of locating buried structure. It is to be remembered, however, that all these observations have been made in proved fields and abandoned wells and until the method has been tried in a new area, either by making temperature observations in core drill holes or drilling wells, it will remain as a possibility and not as a proved fact."--W. Ayvazoglou.

7. UNCLASSIFIED METHODS

(878) CHOICE OF GEOPHYSICAL METHODS IN OIL PROSPECTING

By E. Degolyer

The Petroleum Times, London, vol. 27, No. 694, 1932, pp. 493-494.

The four methods developed, in the author's opinion, to the point of having any claim to practicability in oil prospecting are: The magnetic, gravimetric, electrical, and seismic methods.

Concerning the choise of the method, the author's opinion is that in the present state of development of the geophysical methods for areas where the occurrence of oil pools is controlled by normal folding, the results obtained from seismic surveys, reflection method, are more definite and of greater value than any other type of geophysical information available. A survey of this type is regarded better than any results secured by other methods.

The second choice for all areas, and first choice for areas in which the seismic methods are not usable, would be the gravimetric method.--W. Ayvazoglou.

(879) THE SEARCH FOR OIL IN AUSTRALIA AND DR. WOOLNOUGH'S REPORT

By Frederick G. Clapp

The Petroleum World, London, vol. 29, No. 378, 1932, pp. 75-76.

In this article Clapp gives some remarks on the document entitled "Report on tour of inspection of the oil fields of the United States of America and Argentina, and on oil prospects in Australia," by W. G. Woolnough, geological adviser to the Commonwealth Government (see Geophys. Abs. 37).

Regarding geophysics, to which, according to Clapp, Woolnough pays but a small measure of attention, probably for the reason that the subject is a dangerous one for public consumption, and because more highly technical knowledge is needed for its comprehension than with regard to perhaps any branch of the subject he covers, Clapp, in the paragraph "Use of geophysics," points out that this science should never be used except where designated by a geologist, should never be used broadly except in such definite areas as recommended for the purpose, and its determinations should always be passed upon by a geologist experienced in interpretation of such data. Under proper guidance, what appears to the novice to be a meaningless array of lines, arrows and figures on a map or graph, becomes of positive value, and often enables drilling on the crest of a buried structure that otherwise would remain unknown.--W. Ayvazoglou.

(880) LA PROSPECTION ET L'ORGANISATION DE LA PRODUCTION DES MINES, PARTICULIÈREMENT DANS LES COLONIES

(PROSPECTING AND ORGANIZATION OF PRODUCTION IN MINES, ESPECIALLY IN THE COLONIES)

By Ch. Berthelot

Le Génie Civil, Paris, vol. 99, Nos. 21 and 22, 1931, pp. 522-524 and 554-556.

After a brief remark on the necessity of providing France with minerals which can be obtained from its colonies, the author discusses in the first part of this article the general methods of prospecting which may be used for this purpose. In addition to geological survey the possibility of application of geophysical methods (gravimetric, magnetic, electrical, and seismic) is explained.

The second part of the article deals with the methods of the organization of production.--W. Ayvazoglou.

(881) NEUE METEOROGRAPHEN FÜR DRAHTLOSE FERNÜBERTRAGUNG

(NEW METEOROGRAPHS FOR RADIO TRANSMISSION OF RECORDS)

By Ludwig Heck and Günther Sudeck

Gerlands Beiträge zur Geophysik, Leipzig, vol. 31, No. 1/3, 1931, pp. 291-314.

For the meteorological research of altitude, automatic transmission of the recording of the instruments from a pilot balloon is necessary. By this way the results of the recordings will reach the observer with certainty and without delay. The measured values of air pressure, temperature, and moisture must be transmitted by wireless from the pilot balloon to the ground station.

Two instruments corresponding to the requirements of weight and insensibility to cold are described. The working of both is the following: The angular deflection of the pointer is transformed by scanning with a rotating contact in an impulse. The period of the impulse is proportional to this angle.

This impulse is radiated from a small short-wave transmitter. At the receiving station on the ground this impulse-period is retransformed in a deflection of the recording instrument.

A simple telephotographic receiver is especially adapted as recording instrument. The indications are automatically recorded and the diagrams can be observed during the ascension. The two sending instruments differ from

each other in the way of scanning the measured values. The one instrument works with a rotating contact, controlling the wireless transmitter directly in the plate circuit of the transmitting valve. The other instrument uses a light ray for scanning the measured values, controlling the transmitter by a selenium cell as a variable grid leak. Very light batteries insensible to cold are used.

The experiments in the laboratory, as well as with kite and balloon ascensions, will be continued. The valuation and precision of the diagrams will be published.--Authors' abstract.

(882) GEOPHYSICAL PROSPECTING

By T. H. Laby

Nature, London, vol. 129, No. 3259, 1932, p. 579.

The author, who is one of the editors of "The principles and practice of Geophysical prospecting" (see Geophys. Abs. 23, p. 214) (the other editor being A. B. Broughton Edge), publishes in this note the correction of an error which has crept into the discussion of field tests at Tallong, N. S. Wales, given on page 229 of the book:

> In fig. 176 the east and west indicators have been accidentally interchanged. The same figure indicating the interpretation placed on the geophysical work shows the existence of a mass of alluvium over a mile wide and upwards of 200 feet deep. In the geological map of the Tallong area, reproduced on page 228, no such deposit of anything approaching to this extent and thickness is shown, though the omission of a geologist to indicate such a mass of material would be very serious. As a matter of fact, the deposit is mostly decomposed granite in situ. The mistake in representing this as alluvium is obviously due to the fact that decomposed granite transmits seismic waves comparatively slowly, as would alluvium - namely, at the rate of about 3,000 feet per second. Actually there is outcropping granite over this portion of the area, as shown in the geological map. The use of the term "alluvial velocities" as a general expression for the velocity of a wave through incoherent material is apt to be misleading, and might be discontinued.
>
> In fairness to the geologists who surveyed this area years ago, it must be admitted that the geophysical interpretation, while accurately classifying the material according to the velocities of the transmitted waves, was inaccurate in its presentation of the geological structures of the Tallong area.--W. Ayvazoglou.

8. GEOLOGY

(883) VARISZISCHE ZÜGE DER SCHWEREVERTEILUNG IM GEBIRGSBAU SÜDWEST-UND MITTELDEUTSCHLANDS

(VARISTIC LINES OF GRAVITY DISTRIBUTION IN THE STRUCTURE OF MOUNTAINS OF SOUTHWEST GERMANY AND CENTRAL GERMANY

By Rudolf Herrmann

Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin, vol. 83, No. 10, 1931, pp. 701-731.

Contents:

1. The problem of the latent gravity surpluses.
2. Geological position of the latent gravity surpluses.
   a. Lower Silesia and Lower Lausitz.
   b. East Harz-foreland.
   c. Kraichgau, Franken, and Lorraine.
3. Interpretation.
4. Conclusions.
   a. Gravity and structure of the varistic mountain system.
   b. Disappearance of the varistic gravity.
5. Summary of the main results.
6. Literature.

The figures added show: (1) The relation between the tectonic and gravimetric types; (2) a tectonic map of the southeastern surroundings of the Harz; (3) the places of the Alpine-type gravity distribution in the varistic rocks; (4) the Permian eruptive rocks of the varistic underground layers represented in the Wolff's quartz triangle.--W. Ayvazoglou.

(884) NOTIZEN ZUR ÖLGEOLOGIE UND SALZTEKTONIK

(NOTES CONCERNING OIL GEOLOGY AND SALT TECTONIC)

By Karl Krejci-Graf

Petroleum Zeitschrift, Berlin, vol. 27, No. 48, 1931, pp. 893-897.

The following notes concerning oil geology and salt tectonic are given by the author in this article:

1. The deepest boreholes in the world.
2. The deepest productive boreholes in the world.
3. Boreholes in the sea.
4. Apparatus for measuring the inclination of boreholes.

5. Geophysics -- the use of seismographs in boreholes for determining deep structures is mentioned. A few figures showing the number of salt domes discovered by geophysical methods of prospecting in the Gulf Coast are given.
6. Gas-oil ratio.
7. Oils which are heavier than water.
8. Gas in subrecent layers.
9. Density rule of oils.
10. Distribution of oil and water.
11. Movement of the edge water.
12. Uncommon secondary rocks.
13. Salt tectonic.--W. Ayvazoglou.

9. NEW BOOKS

(885) Alexanian, C. L. Traité pratique de prospection géophysique (Practical treatise on geophysical prospecting). For the use of geologists and mining engineers. 1932, 268 pp., 133 figs., 2 plates. Price: Fr. 62; additional postal charges, in France, Fr. 2.50, Foreign countries, Fr. 5.50 and Fr. 8.00. Librairie Polytechnique Ch. Béranger, 15, Rue des Saints-Pères, Paris. Contents: Introduction -- general rules; Part 1: Direct procedures. Chapter I, Gravimetrical method of prospecting; II, Magnetic method; III, Electrical method (natural currents); IV, Geothermal method; V, Radioactive method; VI, Seismic method; VII, Electrical methods: (1) By measuring electrical potentials; (2) electromagnetic method; (3) by using Hertz's waves. Part 2: Application of geophysical methods of prospection and geological interpretation of the results of measurements. Chapter I, Comparative study of various methods of geophysical prospecting; II, Practical application of the torsion balance; III, Practical application of magnetic method of prospection; IV, Application of electrical method (natural currents); V, Application of geothermal method of prospecting; VI, Application of radioactive method of prospecting; VII, Application of seismic method of prospecting; VIII, Practical application of electrical methods of prospecting. This is a handbook designed to guide the operator in the field and the geologist in the interpretation of the results obtained by measurements.

(886) Berliner, A., and Scheel, K. Physikalisches Handwörterbuch (Hand-dictionary of physical terms). Julius Springer, Berlin, 1932, 2 Auflage VI and 1,428 pp., 1114 figs.; price, R. M. 96. Geophysical terms are considered.

(887) International Research Council. Third report of the Commission appointed to further the study of solar and terrestrial relationships. Percy Lund, Humphries and Co., London, 1931, V - 132 pp.
This is the third of the reports of the Commission to the International Research Council, the first two having been printed and circulated in 1926 and 1929. The report proper, covering the first three pages, deals briefly with the following topics: Publication of the second report,

constitution of the committee, bulletins of daily character figures for solar phenomena, the proposed International Polar Year of 1932-1933, daily magnetic character figures, memoranda on recent progress, and ultraviolet solar radiation. The remaining 129 pages of the publication contain 40 articles by various authors, of which the following may be mentioned as of especial interest: S. Chapman, Solar influences on the Earth's magnetism and on the upper atmosphere; L. d'Azambuja, Sur l'observation des phénomènes éruptifs dans le chromosphère solaire et leurs relations avec les orages magnétiques; H. W. Fisk, Magnetic secular variation and solar activity; J. A. Fleming, Researches of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington bearing on solar activity and the earth's magnetic and electric fields; W. M. H. Greaves, Discussion of the Greenwich solar and magnetic data; R. Gunn, Review of certain contributions to solar and terrestrial magnetism; L. Harang, Memorandum on investigations of aurora at Nordlysobservatoriet (Auroral Observatory), Tromsö; E. O. Hulburt, The ultraviolet-light theory of aurorae and magnetic storms; V. A. Kostitzin, On the relation of magnetic agitation to solar activity; M. et MMe. H. Labrouste, Composantes périodiques de l'activité solaire et composantes correspondantes dans le magnétisme terrestre; J. C. McLennan, On the auroral green line; D. H. Menzel, Auroral phenomena and the solar chromosphere; H. T. Stetson, The correlation of solar and lunar phenomena with the ionization of the earth's atmosphere; C. Störmer, Auroral research.

Professor S. Chapman, the first chairman of the commission, and himself a successful worker in this field, deserves high credit for editing these reports. By inviting the investigators to contribute summaries of their work, he has made the reports fairly complete compendia of the status of our knowledge regarding solar and terrestrial relationships. That this is a distinct help to individual research as well as to collaboration is obvious, considering the fact that the papers on this subject are scattered in physical, geophysical, astronomical, and meteorological journals.

The report is neatly reproduced by the planograph method, which, on account of convenience and economy, is now becoming more widely used for publications of this character. H. D. Harradon's review reprinted from Terrestrial Magnetism and Atmospheric Electricity, Baltimore, vol. 37, No. 1, p. 91, 1932.

10. PATENTS

(888) PROCESS OF AND APPARATUS FOR LOCATING MINERAL DEPOSITS IN SUBSURFACE EARTH STRATA

Thomas S. West, of Drumright, Oklahoma

United States patent 1,845,379. Patent issued February 16, 1932.

The invention relates to an apparatus for locating ore, oil, gas and other mineral substances embodying an electrode adapted to be lowered into a well by an insulated conductor and into electrical connection with a desired stratum, means for insulating said conductor and electrode from a desired portion of the well's wall, means for measuring the magnitude, phase relations, and other characteristics of electric current electrically connected at a point distant from the well with the stratum through a different earth stratum, means connected to the measuring means for regulating the current, and means connected between the regulating means and the conductor for producing an electrical potential difference there between.

Claims allowed - 5.

(889) METHOD AND APPARATUS FOR DETERMINING DISTANCE BY ECHO

Reginald A. Fessenden, of Chestnut Hill, Massachusetts.

United States patent 1,853,119. Patent issued April 12, 1932.

The invention relates to method and apparatus for locating the position of objects by echo, particularly their distance and direction; it includes especially the receipt of such echo by means of a flash of light in connection with a scale whereby observations may be secured from which the distance from a station to the object to be located may be determined.

Claims allowed - 12.

(890) IMPROVEMENTS RELATING TO SEISMOGRAPHS, AND APPLICABLE TO OTHER MEASURING INSTRUMENTS

Anglo-Persian Oil Co., (Ltd.), a British Joint-Stock Corporation, and John Hugh Jones of Hastings, County of Sussex.

British patent 323,552. Patent issued January 9, 1930.

This invention relates to means for indicating or recording small displacements and for indicating or registering minute electrical currents. Means for measuring small displacements or minute electrical currents applicable to

seismographs and other measuring instruments, wherein an iron armature is suspended in a direction transverse to a rapidly varying magnetic field having strongly curved lines of force in such manner that it will take up a position parallel, or nearly parallel, to the tangent to a particular line of force at any particular point, so that on relative movement of the armature and the source of the magnetic field, or on distortion of the magnetic field, the armature will take up a new position.

Claims allowed - 6.

(891) IMPROVEMENTS RELATING TO SEISMOGRAPHS, AND APPLICABLE TO OTHER MEASURING INSTRUMENTS.

Anglo-Persian Oil Co. (Ltd.), of London, a British Joint-Stock Corporation, and John Hugh Jones, Ph.D., of Hastings, County of Sussex.

British patent 343,917. Patent issued February 23, 1931.

This invention relates to an improvement in or modification of the invention described in Specification No. 323,552 and consists in an improved construction of the magnetic magnifier by which greater sensitiveness of operation may be secured.

According to the invention, the magnetic field is produced by a plurality of magnets so disposed that the lines of force in which the magnetic element is set are not only strongly curved but also concentrated to a greater intensity. Moreover, means may be provided, for example, in the form of coils applied to one or more of the magnets, whereby the magnetic field may be controlled as to intensity or direction and may be distorted at will.

Claims allowed - 7.

(892) A PROCESS FOR DETERMINING THE POTASSIUM CONTENT IN SPACES CONTAINING POTASSIUM

Werner Kolhörster of Berlin-Friedenau, Germany.

British patent 340,231. Patent issued December 12, 1930.

The present invention relates to a device for determining the potassium content in spaces which contain potassium compounds in any state of aggregation whatsoever, comprising a tubular ionization vessel with an electrode passing through the same, and having a potential of about 1,000 volts or upwards set up between these two parts, the ionization vessel being affected by the gamma radiation emitted by the potassium so that owing to the high potential difference existing between the outer wall and the inner electrode, an intense ionization by collision is set up so that each incoming ray produces, in an outer circuit, current shocks of such intensity that they are recorded on a recording strip either directly or after amplification has taken place, or are added up by a counting device.

Claims allowed - 1.

(893) IMPROVEMENTS IN APPARATUS FOR DETERMINING POTASSIUM CONTENT IN SPACES CONTAINING POTASSIUM

Werner Kolhörster of Berlin-Lichterfelde, Germany.

British patent 351,266. Patent issued June 25, 1931.

This invention relates to an improvement or modification of the invention set forth in Patent Specification No. 40,231.

According to the present invention, the improvement or modification consists of the fact that the apparatus for determining the potassium content includes a rotating impulse relay in the form of a rotative selector as used in automatic telephony, or a continuous current electrical meter, adapted to summate and indicate current impulses of high frequency, as produced by the ionization set up by the gamma rays emitted by the potassium. Preferably, means is provided whereby the current impulses to be summed and indicated are first amplified.

Claims allowed - 9.

(894) METHOD AND APPARATUS FOR DETECTING MINERAL AND OTHER DEPOSITS

Doctor Günther Laubmeyer of Kassel-Wilhelmshöhe, Germany.

British patent 352,269. Patent issued July 9, 1931.

The method according to the invention consists in collecting underground air by means of a special apparatus and in testing it quantitatively as to the existence of gaseous substances which are in direct relation with the deposits. The apparatus used for working the method is constructed with the purpose of not giving any possibility of interchange with the open air to the underground air which has been collected by parts of the apparatus.

The apparatus is constructed as a closure or lid for borings, the lid having besides an outlet pipe at least one cylinder or the like surrounding the outlet pipe; the diameter of this cylinder being larger than that of the borehole. A particularly preferred construction which has been found very practicable contains two concentrically arranged cylinders, is provided with an outlet pipe and closes the borehole tightly.

Claims allowed - 7.

INDEX[3]

3 The first figure refers to the number of the abstract, the second to the method of prospecting as indicated in the Table of Contents, and the third to the page.

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I. C. 6647 JULY, 1932

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

SILVER CONSUMPTION IN THE ARTS AND INDUSTRIES OF THE UNITED STATES IN 1930 AND 1931

BY

Charles White Merrill

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

SILVER CONSUMPTION IN THE ARTS AND INDUSTRIES OF THE UNITED STATES IN 1930 AND 1931 (1)

By Charles White Merrill (2)

INTRODUCTION

Silver consumption in the arts and industries of the United States during 1930 and 1931 has remained remarkably near the high level established in 1929. Undoubtedly the sharp drop in the price of silver has been an important factor in supporting consumption, but silver's peculiar properties and uses probably have been an even more compelling reason for its sustained utilization. In its most important use - sterling silverware - it seemingly has most serious competition, but well established tradition protects the demand for sterling ware and the law forbids the term "sterling" to be applied to any material not containing at least 92.5 per cent silver. The photographic industry is dependent upon properties of certain silver salts possessed by no other material. Consequently silver is indispensable to all photography, including the huge motion picture industry. Other uses for silver could be listed which, because of special features, likewise have tended to maintain the consumption of silver in the arts and industries of the United States.

The figures which this report makes available for the first time are the detailed silver consumption figures for the arts and industries of the United States for 1930 and 1931. These figures have been tabulated with the previously published(3) figures for 1928 and 1929, thus presenting a 4-year statistical record of silver consumption. All quantities are given in troy ounces, 1,000 fine.

SUMMARY

The total consumption of silver in the arts and industries of the United States was 23,578,955 ounces in 1931, compared with 23,981,164 ounces in 1930, 28,601,311 ounces in 1929, and 25,826,554 ounces in 1928. The consumption for 1930 represents a decrease of 16 per cent compared with 1929, but the 1931 consumption is less than 2 per cent below that for 1930. Total turnover of silver by the arts and industries of the United States was 35,-252,656 ounces in 1931 compared with 35,119,520 ounces in 1930, 41,426,263 ounces in 1929 and 37,238,683 ounces in 1928. The ratio of scrap returned to smelters and refiners to total turnover has increased progressively during the past four years from 30.6 per cent in 1928 to 33.1 per cent in 1931. Manufacturing losses of silver continue to be negligible compared with the quantity of silver handled. Table 1 summarizes the consumption and turnover of silver in the domestic arts and industries.

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1 - The Bureau of Mines will welcome reprinting of this paper, provided the following foot note acknowledgment is used: "Reprinted from the U. S. Bureau of Mines Information Circular 6647."

2 - Associate mineral economist, common metals division, U. S. Bureau of Mines.

3 - Merrill, Charles White, Consumption of Silver in the Arts and Industries of the United States: Econ. Paper 14, Bureau of Mines, 1932.

Table 1.--Silver consumed by industries making products for ultimate consumption

	1928		1929		1930		1931	
	Quantity of silver, fine ounces	Per cent	Quantity of silver, fine ounces	Per cent	Quantity of silver, fine ounces	Per cent	Quantity of silver, fine ounces	Per cent
Sterling silver industry	9,429,922	36.4	9,871,644	34.4	7,548,803	31.5	8,823,593	37.4
Photographic industry (1)	6,560,812	25.4	7,616,741	26.6	7,546,451	31.5	6,587,623	27.9
Electroplating industry(1)	3,840,519	14.9	4,110,129	14.4	2,777,954	11.6	2,307,731	9.8
Jewelry, optical goods and novelties industry (2)	2,211,465	8.6	2,570,075	9.0	2,194,906	9.2	2,073,615	8.8
Chemical industry (1) (exclusive of photographic and electroplating)	1,537,890	6.0	1,753,863	6.2	1,685,701	7.0	1,461,548	6.2
Industrials, including silver solder (2)	1,699,399	6.6	1,974,908	6.9	1,153,615	4.8	1,224,820	5.2
Dental supplies	501,802	1.9	598,322	2.1	611,369	2.5	649,984	2.8
Miscellaneous consumption (2)	5,950	0.0	80,855	0.3	384,223	1.6	358,547	1.5
Total silver content of products	25,787,759	99.8	28,576,537	99.9	23,903,022	99.7	23,487,461	99.6
Total losses (estimated)	38,795	0.2	24,774	0.1	78,142	0.3	91,494	0.4
Total silver consumption	25,826,554	100.0	28,601,311	100.0	23,981,164	100.0	23,578,955	100.0
Scrap sent to smelters and refiners	11,412,129		12,824,952		11,138,356		11,673,701	
Total silver turnover	37,238,683		41,426,263		35,119,520		35,252,656	

1 - The chemical industry made products containing 9,652,213 fine ounces in 1928, 11,151,286 ounces in 1929, 11,401,719 ounces in 1930, and 10,174,388 ounces in 1931. This silver entered ultimate consumption or was returned to smelters or refiners as scrap through the photographic, electroplating, and mirror industries, was partly consumed as chemicals in laboratories and in medicines, and was sold through jobbers to unclassified users.

2 - Manufacturers that alloy, roll, draw, and rolled-plate precious metals made products containing 3,916,814 fine ounces of silver in 1928, 4,625,838 ounces in 1929, 3,732,744 ounces in 1930, and 3,656,982 ounces in 1931, exclusive of those sold to silversmiths. This silver entered ultimate consumption as jewelry, optical goods, novelties, industrial products, and in other forms.

The sterling silver industry used only 76 per cent as much silver in 1930 as in 1929, but the consumption for 1931 showed a marked recovery. This recovery undoubtedly was partly the result of the lower price of silver which made possible the lowest retail price of sterling silverware ever quoted.

The photographic industry continued to consume silver in 1930 at approximately the 1929 rate but there was a 13 per cent decrease in 1931 compared with 1930. The consumption of silver in the photographic industry closely parallels activity in the moving picture industry, its most important customer. In the field of still photography some increase of silver consumption can be expected as a result of the introduction of a new type of panchromatic film for popular use. This new type of film which records the reds and yellows more satisfactorily, is said to contain about twice as much silver as does the ordinary type of popular film.

The electroplating industry has shown a sharper decline in silver consumption for 1930 and 1931 than any other important silver-using industry. The consumption in 1930 showed a 32 per cent decrease from that for the previous year and was followed by a further decrease of 17 per cent in 1931 compared with 1930. Although it is probable that during the past two years there has been an increase in the use of unplated and very light plated ware at the expense of better-quality electroplated silver ware, a resumption of demand for the heavily plated ware, because of its greater durability and ultimate economy, may be expected with the return of more normal conditions.

Jewelry, optical goods, and novelties required 15 per cent less silver in 1930 than in 1929, but the 1931 consumption almost equalled the 1930 figure. Apparently the vogue for costume jewelry, metal frames for glasses, and metal novelties has not waned greatly.

The chemical industry is a very large consumer of silver, but most of its products are passed on in a semifinished state to the photographic and electroplating industries. Silver chemicals that were consumed by the mirror industry, in medicine, in laboratories, and other industries besides those mentioned, contained 1,685,701 ounces of silver in 1930 and 1,461,-548 ounces in 1931. These figures represent a moderate decline from the figures for 1929 and 1928.

The consumption of silver by the so-called industrials showed a decrease of 42 per cent in 1930 compared with 1929, but there was a small recovery in 1931. Silver solders continued to be the most important form in which this silver was consumed. The mechanical refrigerator industry appears to be the principal user of silver solders. Many other industries utilize this type of solder, as well as other forms of silver, in their manufactures.

There has been steadily increasing consumption of silver for dental supplies. In 1928, 501,802 ounces entered this industry; in 1929, 598,322 ounces; in 1930, 611,369 ounces; and in 1931, 649,984 ounces.

The following pages are devoted to tables giving details of silver consumption in the principal industries using it, with brief paragraphs explanatory of the tables they accompany.

CHEMICAL INDUSTRY

The quantity of silver used in the manufacture of chemicals exceeds that used in any other industry, but only a small part of this silver reaches the ultimate consumer in the chemical form. A much larger portion is absorbed in the manufactures of photographic supplies, in electroplating and in mirror making. Silver chemicals used for medicinal or la - oratory purposes are virtually the only silver chemicals that may be considered as entering ultimate consumption directly. Table 2 presents data relative to the flow of silver in the chemical industry.

Table 2.--Silver bought by the chemical industry and its Disposal in consumption

(Troy ounces - 1,000 fine)

	1928	1929	1930	1931
Products:				
Silver nitrate	9,506,105	10,976,629	11,293,660	10,055,547
Other silver salts	146,108	174,657	108,059	118,841
Total silver content of finished products	9,652,213	11,151,286	11,401,719	10,174,388
Estimated losses	700	750	7,141	5,193
Total silver consumption	9,652,913	11,152,036	11,408,860	10,179,581
Scrap sent to smelters and refiners	6,605	12,980	11,300	17,728
Total silver turnover (purchases)	9,659,518	11,165,016	11,420,160	10,197,309
Disposal:				
Photographic industry	7,910,605	9,169,260	9,589,764	8,573,781
Silver-electroplating industry	203,718	228,163	126,254	139,059
Mirror industry	325,346	360,113	277,342	348,033
Laboratory and medicinal uses	235,676	220,272	7,978	45,319
Miscellaneous industries and to jobbers (1)	976,868	1,173,478	1,400,381	1,068,196
Total silver content of sales	9,652,213	11,151,286	11,401,719	10,174,388

1 - Owing to the fact that some manufacturers were unable to distribute their sales according to uses, these figures probably include substantial quantities of silver which were ultimately used for the purposes enumerated above.

Silver nitrate continues to be the chief product of the industry. Manufacturing losses and returns of scrap to smelters and refiners remain negligible. The total 1931 output, although less than in 1930, was greater than in 1928, and the 1930 production exceeded that for 1929. The quantities sold to the photographic and the miscellaneous industries paralleled the fluctuations in the silver chemical industry as a whole, but the sales to electroplaters and mirror-makers show a sharp decline in 1930, followed by some recovery in 1931. Laboratory and medicinal uses show a smaller consumption in 1930 and 1931 than in 1928 and 1929, but, as this resulted from less detailed reports made by some of the silver chemical manufacturers, consumption formerly attributed to these uses appears in the figures for miscellaneous industries and jobbers, a classification that also contains much silver that ultimately finds its way into the electroplating and mirror industries.

STERLING SILVERWARE INDUSTRY

Sterling silverware consumes approximately one-third of the silver entering the arts and industries of the United States; its manufacture is responsible for approximately one-half of the turnover of silver in the arts and industries. The scrap returned to smelters and refiners by silversmiths accounts for about three-fourths of the total silver scrap returned by industry. Table 3 presents the flow of silver in the sterling silverware industry.

Table 3.--Silver bought by silversmiths and its disposal in consumption

(Troy ounces - 1,000 fine)

	1928	1929	1930	1931
Products:				
Flatware	5,535,521	5,600,049	4,609,739	5,909,233
Holloware	2,689,827	2,962,215	2,273,044	2,266,444
Toiletware, jewelry and novelties	1,204,574	1,309,380	666,020	647,916
Total silver content of finished products	9,429,922	9,871,644	7,548,803	8,823,593
Estimated losses	16,775	16,814	41,949	60,696
Total silver consumption	9,446,697	9,888,458	7,590,752	8,884,289
Scrap sent to smelters and refiners	8,971,830	9,829,467	8,211,372	8,927,274
Total silver turnover	18,418,527	19,717,925	15,802,124	17,811,563
Purchases:				
Sterling silver (925 fine)	15,704,146	17,091,466	13,403,598	14,656,321
Bar silver (999 fine)	2,608,663	2,492,002	2,297,382	3,083,237
Silver solders	97,398	127,129	95,666	70,193
Silver in other forms (principally scrap)	8,320	7,328	5,478	1,812
Total silver content of purchases	18,418,527	19,717,925	15,802,124	17,811,563

Consumption of silver for sterling flatware in 1931 increased 28 per cent over that for 1930 and was greater than in either 1928 or 1929. Holloware, however, has shown a decrease in its silver requirements since 1929 and the silver consumption for toiletware, jewelry, and novelties in 1930 and 1931 has been approximately one-half of that in 1928 and 1929. The quantity of scrap sent to smelters and refiners slightly exceeded the quantity contained in finished products. The total consumption and total turnover of silver in the sterling silver industry were less in 1930 and 1931 than in 1928 and 1929, but it is encouraging to note that in both items 1931 exceeded 1930 by over 12 per cent.

Silversmiths continued to buy the bulk of their silver as the sterling alloy (1930, 85 per cent, 1931, 82 per cent), the remainder being principally bar silver (999 fine) but including small quantities purchased as silver solders and scrap.

PHOTOGRAPHIC INDUSTRY

The photographic industry is second only to the sterling silver industry in ultimate consumption of silver. Consumption in 1930 almost equalled the high figure set in 1929, but the 1931 consumption decreased 13 per cent to approximate that for 1928. Table 4 presents the ata relative to the flow of silver in the photographic industry.

Table 4.--Silver bought by the photographic industry and its disposal in consumption

(Troy ounces - 1,000 fine)

Products	1928	1929	1930	1931
All products including photoengraving	6,560,812	7,616,741	7,546,451	6,587,623
Estimated losses	15,127	127	20,000	18,000
Total silver consumption	6,575,939	7,616,868	7,566,451	6,605,623
Scrap sent to smelters and refiners	1,334,666	1,552,392	2,023,313	1,968,158
Total silver turnover (purchases)	7,910,605	9,169,260	9,589,764	8,573,781

The proportion of the purchases returned to smelters and refiners as scrap has increased progressively since 1928, reaching 23 per cent of the total purchases in 1931.

ELECTROPLATED SILVERWARE INDUSTRY

The silver consumption of the electroplated silverware industry has declined more in 1930 and 1931 than that of any other important silver-consuming industry. The decline has been distributed fairly evenly among the three classifications of electroplated ware. The quantity returned to smelters and refiners shows a corresponding decline. Table 5 presents the data relative to the flow of silver in the electroplating industry.

Table 5.--Silver bought by the electroplating industry and its disposal in consumption

(Troy ounces - 1,000 fine)

	1928	1929	1930	1931
Products:				
Flatware	3,083,213	3,358,473	2,171,847	1,901,254
Holloware	551,356	556,214	530,370	338,179
Toiletware, jewelry and novelties	205,950	195,442	75,737	68,298
Total silver content of finished products	3,840,519	4,110,129	2,777,954	2,307,731
Estimated losses	5,223	6,064	5,125	3,810
Total silver consumption	3,845,742	4,116,193	2,783,079	2,311,541
Scrap sent to smelters and refiners	850,964	1,118,189	726,362	575,902
Total silver turnover	4,696,706	5,234,382	3,509,441	2,887,443
Purchases:				
Metallic silver exclusive of solders (principally anodes)	4,447,077	4,959,299	3,340,709	2,716,448
Silver salts	203,718	228,163	126,254	139,059
Silver solders	45,911	46,920	42,478	31,936
Total silver content of purchases	4,696,706	5,234,382	3,509,441	2,887,443

Purchase of silver by this industry continued to consist principally of metallic silver which is used as anodes. Some silver entered the industry, however, in the form of silver salts and silver solders.

PRODUCTS OF THE PRECIOUS METALS ALLOYING, ROLLING, DRAWING, AND ROLLED-PLATING INDUSTRY (EXCLUSIVE OF PRODUCTS SOLD TO SILVERSMITHS)

The output of the alloyers and fabricators of precious metals includes a wide variety of semifinished products which are sold principally to manufacturers of sterling silverware, jewelry, optical goods, novelties, and various industrials. The products sold to silversmiths have been eliminated from this section of the report to avoid duplication. Data concerning them appear in the section on sterling silverware as purchases of sterling silver and silver solders, items totaling 13,499,264 ounces in 1930 and 14,726,514 ounces in 1931. Table 6 presents the data relative to the flow of silver in this industry, exclusive of that sold to silversmiths.

Table 6.--Silver bought by the precious metals alloying, rolling, drawing, and rolled-plating industry and its disposal in consumption exclusive of products sold to silversmiths)

(Troy ounces - 1,000 fine)

	1928	1929	1930	1931
Products:				
All products including silver solders	3,916,814	4,625,838	3,732,744	3,656,982
Estimated losses	893	921	3,295	3,042
Total silver consumption	3,917,707	4,626,759	3,736,039	3,660,024
Scrap sent to smelters and refiners	234,236	287,461	117,907	129,515
Total silver turnover (purchases)	4,151,943	4,914,220	3,853,946	3,789,539
Disposal:				
Jewelry, optical goods and novelties industries	2,211,465	2,570,075	2,194,906	2,073,615
Industrials	1,699,399	1,974,908	1,153,615	1,224,820
Others	5,950	80,855	384,223	358,547
Total silver content of sales	3,916,814	4,625,838	3,732,744	3,656,982

A sharp decline is noted for most of the items in this table between the years 1929 and 1930. The figures for 1931, however, are nearly equal in all cases to those recorded for 1930.

DENTAL SUPPLIES INDUSTRY

The dental supplies industry is the only one that shows a steadily increasing silver consumption since 1928. Table 7 presents the data relative to the flow of silver in the dental supplies industry.

Table 7.--Silver bought by the dental supplies industry and its disposal in consumption

(Troy ounces - 1,000 fine)

Products	1928	1929	1930	1931
Silver alloys for amalgam fillings	419,544	505,309	519,591	562,713
Other dental supplies	82,258	93,013	91,778	87,271
Total silver content of finished products	501,802	598,322	611,369	649,984
Estimated losses	77	98	632	753
Total silver consumption	501,879	598,420	612,001	650,737
Scrap sent to smelters and refiners	13,828	24,463	48,102	55,124
Total silver turnover (purchases)	515,707	622,883	660,103	705,861

Mirror Industry

The mirror industry continued to consume a substantial quantity of silver. Mirror manufacturers are supplied with silver in the form of silver nitrate. Table 2 gives data on the consumption of silver in the mirror industry. The consumption for 1930 was well below that for 1929, but that for 1931 shows a 25 per cent increase from the 1930 level.

I. C. 6648

September, 1932

Department of Commerce

UNITED STATES BUREAU OF MINES
Scott Turner, Director

INFORMATION CIRCULAR

SURVEY OF CRACKING PLANTS

JANUARY 1, 1932

BY

G. R. Hopkins

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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

SURVEY OF CRACKING PLANTS, JANUARY 1, 1932[1]

By G. R. Hopkins[2]

Introduction

The total daily charging capacity of the cracking plants in the United States as of January 1, 1932, amounted to the record total of 2,046,981 barrels. This represents an increase over the previous year of 96,200 barrels, or 5 per cent. Although the increase in total charging capacity of the cracking plants during 1931 was considerably less than in 1930, it was about three times the increase in the capacity for straight distillation.[3]

The total daily charging capacity of the plants operating on January 1, 1932, amounted to 1,603,809 barrels, or 78 per cent of the total; the capacity of the inoperative plants was 394,585 barrels, or 19 per cent; that of the plants under construction was 48,587 barrels, or 3 per cent. Compared with a year ago, these data represent a small increase in operative capacity, a large gain in inoperative capacity, and a large decrease in the capacity under construction. The refinery survey showed a comparable increase in the inoperative capacity of the equipment used for straight distillation, but showed a decrease in operative capacity and a much larger relative decline in the capacity under construction. These facts indicate an expansion in cracking at the expense of skimming.

In cracking, as in practically all industrial operations, capacity may be increased either by constructing new units or by remodeling existing equipment. Until five years ago most of the capacity that was added consisted of new equipment, but the last few years have witnessed a tendency to increase the potential throughput by modernizing existing units. It is estimated that at least 125,000 barrels of daily cracking capacity was added through remodeling in 1931, compared with about 150,000 barrels added through the construction of new equipment. On the other hand, the cracking capacity is also reduced in two ways, by the dismantling of old units and through obsolescence. It is estimated that about 110,000 barrels of capacity was dismantled in 1931 and that about 70,000 barrels was lost through obsolescence.

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1 The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6648."
2 Economic analyst, U. S. Bureau of Mines.
3 Hopkins, G. R., and Cochrane, E. W., Petroleum Refineries in the United States, January 1, 1932: Bureau of Mines Information Circular 6641.

The number of cracking units as of January 1, 1932, totaled 1,348, compared with 1,368 a year ago. This material decline resulted chiefly from the dismantling of a large number of Burton stills of small average capacity. The number of units has shown a steady decrease in recent years, the total capacity a steady increase. This trend is indicative of the tendency of refiners to replace small, obsolete units by one or two large modern units. For example, the average size of the cracking units on June 1, 1925, the date of the first cracking survey, was 330 barrels; on January 1, 1932, it was approximately 1,500 barrels.

Texas continued to rank far ahead of the other States in total capacity of cracking plants; California was second, Indiana third. The total capacity of the cracking plants in Texas, which are largely concentrated on the Gulf coast, amounted to 645,720 barrels, or 32 per cent of the total for the United States. In a number of States the capacity of the plants dismantled in 1931 exceeded the increase due to new construction or to the remodeling of old units. Wyoming showed the largest decrease in capacity during 1931; Oklahoma showed a decline for the second successive year.

Thirty-seven different types of cracking processes were reported in this survey compared with 35 a year ago and with 27 in 1925. Approximately half of the number of types listed in 1925 were reported in the 1932 survey, from which it may be assumed that about two dozen new types have been developed in the intervening seven years. The number of processes showed the most rapid increase in 1928; since then the number of new processes developed has about equaled the number no longer reported. The various types of cracking processes may be divided into two general classes, one comprising those which have been actively licensed, the other made up of those that have been used exclusively by the respective companies which designed them. For purposes of designation, these groups will be referred to as the "license" and "own" groups. At the time of th bureau's first survey (1925) the license group was of primary importance, but the last few years have witnesses a rapid increase in the capacity of the "own" group. For example, between January 1, 1931, and January 1, 1932, the total capacity of the "own" group rose from about 930,000 barrels to 1,060,000 barrels; the total capacity of the license group declined from about 1,020,000 barrels to 990,000 barrels in the same period.

Cracking processes may be further divided into those which operate in the liquid phase and those which operate in the vapor phase. Liquid-phase processes were the first to be developed. The development of vapor-phase units was given an impetus by the discovery that the gasoline produced by them had an unusually high antiknock rating. Thus the total capacity of the vapor-phase units practically doubled between January 1, 1930, and January 1, 1932. However it should be noted that the total daily capacity as of January 1, 1932 (60,350 barrels), represented only about 3 per cent of the total.

The production of gasoline by cracking has shown a steady increase in recent years; in 1931, the output of cracked gasoline totaled 176,181,000 barrels, an increase of 7 per cent over 1930. As the output of all grades of gasoline at refineries showed a small decrease in 1931, it follows that the proportion of cracked gasoline to the total increased materially. It might be assumed that, in times of low crude prices such as prevailed in 1931, the skimming of crude oil would be preferable to cracking. Actually the reverse held true; that is, cracking increased materially and skimming declined. At some refineries all the skimming units were shut down for months at a time and only the cracking plants operated. In some cases this was due to a restriction in the supply of crude oil, but in general it was a tribute to the increased efficiency of cracking plants.

Data as to the gasoline yields obtained by cracking vary widely depending upon the type of process, the charging stock, and the extent of recycling. In 1925 the average gasoline yield reported by all the companies was 33 per cent of the charging stock. In 1931 an analysis of the reports of about 25 large companies showed a yield of 45 per cent, indicating a material improvement in efficiency.

RECAPITULATION BY YEARS

Year	Total units	Charging capacity, barrels per day			
		Operating	Shut down	Building	Total
June 1, 1925	2,527	690,492	26,200	116,000	832,692
June 1, 1926	2,559	844,800	47,690	47,600	940,090
Jan. 1, 1928	2,334	1,013,000	253,000	22,000	1,288,000
Jan. 1, 1929	2,205	1,194,501	147,923	134,450	1,476,874
Jan. 1, 1930	2,002	1,419,200	139,840	149,900	1,708,940
Jan. 1, 1931	1,868	1,594,990	244,661	111,130	1,950,781
Jan. 1, 1932	1,348	1,603,809	394,585	48,587	2,046,981

RECAPITULATION BY DISTRICTS (January 1, 1932)

District	Total units	Charging capacity, barrels per day			
		Operating	Shut down	Building	Total
East Coast	170	255,000	78,800	7,040	340,840
Appalachian	60	56,450	10,700	- -	67,150
Ind., Ill., Ky., etc.	267	264,850	62,400	12,000	339,250
Okla., Kans., etc. .	264	199,200	48,800	15,000	263,000
Texas Inland	67	92,270	44,350	- -	136,620
Texas Gulf coast ...	180	417,000	88,100	4,000	509,100
Ark. and Inland La..	33	26,000	9,650	- -	35,650
La. Gulf coast	40	71,800	2,600	3,000	77,400
Rocky Mountain	189	36,289	29,985	7,547	73,821
California	78	184,950	19,200	- -	204,150
U. S. Total	1,348	1,603,809	394,585	48,587	2,046,981

RECAPITULATION BY STATES (January 1, 1932)

State	Total units	Charging capacity, barrels per day			
		Operating	Shut down	Building	Total
Alabama	1	- -	- -	3,000	3,000
Arkansas	21	10,500	6,250	- -	16,750
California	78	184,950	19,200	- -	204,150
Colorado	12	3,459	411	- -	3,870
Georgia	2	3,600	- -	- -	3,600
Illinois	112	75,700	21,900	- -	97,600
Indiana	129	132,050	40,500	12,000	184,550
Iowa	1	- -	1,000	- -	1,000
Kansas	91	79,500	30,050	12,500	122,050
Kentucky	8	10,000	- -	- -	10,000
Louisiana	51	87,300	6,000	- -	93,300
Maryland	22	24,200	15,200	- -	39,400
Massachusetts	16	22,300	8,000	- -	30,300
Michigan	3	3,750	- -	- -	3,750
Missouri	26	15,500	4,500	- -	20,000
Montana	4	2,800	2,000	- -	4,800
New Jersey	48	93,300	15,200	7,040	115,540
New York	14	19,600	- -	- -	19,600
Ohio	28	62,100	- -	- -	62,100
Oklahoma	146	104,200	13,250	2,500	119,950
Pennsylvania	94	116,250	32,700	- -	148,950
Rhode Island	3	6,000	- -	- -	6,000
South Carolina	8	- -	14,400	- -	14,400
Texas	247	509,270	132,450	4,000	645,720
Utah	33	6,400	3,800	1,000	11,200
West Virginia	10	7,450	4,000	- -	11,450
Wyoming	140	23,630	23,774	6,547	53,951
U. S. Total	1,348	1,603,809	394,585	48,587	2,046,981

RECAPITULATION BY TYPE OF PROCESS

Type of process	January 1, 1932		January 1, 1931	
	Total units	Total capacity, barrels per day	Total units	Total capacity, barrels per day
Black	12	16,000	12	16,000
Burton	320	83,774	793	164,249
Carborundum	1	3,000	1	3,000
Coil cracker	-	-	2	8,000
Combination	1	12,000	-	-
Continuous high-pressure.	3	10,947	2	5,300
Controlled coil	8	24,500	2	4,500
Convertor	1	4,800	1	4,200
Cross	151	241,370	150	245,800
de Florez	12	24,700	6	13,550
Doherty	21	29,000	20	27,500
Donnelly	3	5,500	4	7,000
Dubbs	173	261,950	185	252,250
Fleming	3	600	2	800
Gyro	21	20,400	20	16,000
Holmes-Manley	113	262,200	115	233,900
Isom	95	123,500	115	179,150
Jenkins	44	65,300	46	66,150
Leamon	5	2,500	5	2,250
Lewis	4	6,200	4	6,200
Lientz	1	6,000	1	6,000
Link	22	46,000	22	46,000
Louisiana coil	-	-	5	7,100
Ormont	4	1,000	4	1,000
Own	119	168,500	166	168,000
Pipe Stills	3	13,000	3	13,000
Pratt	2	2,500	2	2,500
Pressure-coke	11	19,000	13	22,000
Richmond	1	3,000	2	6,400
Rowsey	1	10,000	-	-
Sinclair Type 600	25	87,000	-	-
Skelly-Rittman vapor-phase	2	2,500	2	2,500
Slagter	15	2,250	18	2,700
Snodgrass	7	2,700	14	4,972
Solar	1	7,150	-	-
True vapor-phase	2	4,600	2	3,600
Trumble	1	750	1	750
Tube-and-tank	127	441,540	118	385,460
Vapor-phase	2	2,150	3	4,200
Winkler-Koch	11	29,100	7	18,800
Total	1,348	2,046,981	1,868	1,950,781

SURVEY OF CRACKING PLANTS, JANUARY 1, 1932

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	ALABAMA				
Bldg.	Coastal Pet. Corp.	Mobile	1	3,000	Own
			1	3,000	
	ARKANSAS				
Sd.	Houston Oil Co. of Texas	Camden	2	2,000	Dubbs
Sd.	Kettle Creek Refg. Co.	El Dorado	2	2,000	Do.
Op.	Lion Oil Refg. Co.	do.	10	3,500	Burton
Op.	do.	do.	1	2,500	Own
Sd.	Ouachita Valley Refg. Co.	do.	1	750	Dubbs
Sd.	Root Refg. Co.	do.	2	1,500	Do.
Op.	do.	do.	1	2,500	Winkler-Koch
Op.	Simms Oil Co.	Smackover	2	2,000	Cross
			21	16,750	
	CALIFORNIA[1]				
Op.	Associated Oil Co.	Avon	1	10,000	Tube-and-tank
Op.	Hercules Gasoline Co.	Los Angeles	1	1,250	Jenkins
Sd.	Richfield Oil Co. of Calif.	Hynes	4	14,000	Cross
Op.	do.	Watson	12	16,000	Black
Op.	Rio Grande Oil Co.	Vinvale	2	2,000	Jenkins
Op.	Shell Oil Co.	Dominguez	8	34,000	Dubbs
Op.	do.	Martinez	8	15,200	Do.
Op.	do.	do.	1	4,800	Convertor
Op.	do.	Watson	8	18,000	Dubbs
Op.	Standard Oil Co. of Calif.	El Segundo	12	36,300	Do.
Op.	do.	Richmond	8	18,200	Do.
Op.	The Texas Co.	Fillmore	1	2,700	Cross
Op.	do.	Watson	3	5,500	Holmes-Manley
Op.	Union Oil Co. of Calif.	Wilmington	4	12,000	Cross
Op.	do.	do.	1	6,000	Lientz
Op.	do.	do.	1	3,000	Carborundum
Sd.	Vulcan Refg. Co.	Los Angeles	1	1,000	Vapor phase
Sd.	Western Oil & Refg. Co.	do.	2	4,200	Jenkins
			78	204,150	

1 Data compiled by E. T. Knudsen of the San Francisco Office of the U. S. Bureau of Mines.

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	COLORADO				
Op.	Continental Oil Co.	Denver	1	1,000	Cross
Op.	do.	Florence	7	959	Burton
Sd.	do.	do.	3	411	do.
Op.	The Texas Co.	Craig	1	1,500	Holmes-Manley
			12	3,870	
	GEORGIA				
Op.	The Atlantic Refg. Co.	Brunswick	2	3,600	Lewis
			2	3,600	
	ILLINOIS				
Op.	The Globe Oil & Refg. Co.	Lemont	1	3,000	Winkler-Koch
Op.	Indian Refg. Co.	Lawrenceville	8	8,000	Cross
Op.	Lincoln Oil Refg. Co.	Robinson	4	7,600	Holmes-Manley
Op.	Lubrite Refg. Corp.	E. St. Louis	2	2,500	Pratt
Op.	Shell Pet. Corp.	Wood River	11	9,200	Dubbs
Sd.	do.	do.	3	2,800	do.
Sd.	do.	do.	4	3,600	Cross
Op.	do.	do.	1	4,000	True vapor-phase
Sd.	Standard Oil Co. (Ind.)	do.	60	15,500	Burton
Op.	do.	do.	6	22,300	Holmes-Manley
Op.	The Texas Co.	Lockport	6	10,000	do.
Op.	do.	do.	1	2,000	de Florez
Op.	do.	do.	2	4,000	Pressure-coke
Op.	White Star Refg. Co.	Wood River	3	3,100	Dubbs
			112	97,600	
	INDIANA				
Op.	Bartles-Maguire Oil Co.	E. Chicago	2	2,000	Jenkins
Op.	do.	do.	1	1,150	Vapor-phase
Op.	Empire Oil & Refg. Co.	do.	10	15,000	Doherty
Op.	Shell Pet. Corp.	do.	8	13,000	Dubbs
Op.	Sinclair Refg. Co.	do.	10	13,000	Isom
Sd.	do.	do.	25	32,500	do.
Op.	do.	do.	8	22,500	Sinclair Type 600

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	INDIANA (Cont'd)				
S.d.	Standard Oil Co. (Ind.)	Whiting	40	8,000	Burton
Op.	do.	do.	22	61,000	Holmes-Manley
Op.	do.	do.	2	4,400	Continuous high-pressure
Bldg.	do.	do.	1	12,000	Combination
			129	184,500	
	IOWA				
S.d.	MonaMotor Oil Co.	E. Omaha	1	1,000	Cross
			1	1,000	
	KANSAS				
Op.	Altitude Pet. Corp.	Chanute	2	3,000	Jenkins
Op.	Barnsdall Refineries (Inc.)	Wichita	4	1,500	Dubbs
Op.	Derby Oil Co.	do.	2	1,500	do.
S.d.	do.	do.	2	1,000	do.
Op.	El Dorado Refg. Co.	El Dorado	1	2,000	Winkler-Koch
Op.	Golden Rule Refg. Co.	Wichita	1	1,200	Jenkins
S.d.	Hutchinson Oil Refg. Co.	Hutchinson	1	750	Trumble
Op.	Independent Oil & Gas Co.	Kansas City	1	2,500	Dubbs
S.d.	Kanotex Refg. Co.	Arkansas City	2	2,400	Jenkins
Op.	do.	do.	1	2,500	Donnelly
Op.	do.	do.	1	1,200	Jenkins
Op.	National Refg. Co.	Coffeyville	1	1,500	Own
Op.	Shell Pet. Corp.	Arkansas City	6	5,600	Dubbs
S.d.	do.	do.	2	1,400	do.
Bldg.	Sinclair Refg. Co.	Coffeyville	2	10,000	Sinclair Type 600
Op.	do.	do.	10	13,000	Isom
S.d.	do.	Argentine	10	13,000	do.
S.d.	Skelly Oil Co.	El Dorado	9	9,000	Jenkins
Op.	do.	do.	7	13,000	Pipe still
S.d.	do.	do.	2	2,500	Skelly-Rittman vapor-phase
Op.	The Standard Oil Co. (Kans.)	Neodesha	20	12,000	Burton
Op.	do.	do.	1	2,500	Holmes-Manley
Bldg.	do.	do.	1	2,500	do.
Op.	Vickers Pet. Co. of Del.	Potwin	2	1,500	Dubbs
Op.	White Eagle Oil Corp.	Augusta	4	15,000	Controlled coil
			95	122,050	

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	KENTUCKY				
Op.	Aetna Oil Service (Inc.)	Louisville	2	400	Fleming
Op.	Ashland Refg. Co.	Catlettsburg	1	1,000	Dubbs
Op.	Latonia Refg. Corp.	Latonia	2	4,800	Tube-and-tank
Op.	Louisville Refg. Co. (Inc.)	Louisville	2	1,800	Dubbs
Op.	The Texas Co.	Pryse	1	2,000	Holmes-Manley
			8	10,000	
	LOUISIANA				
Op.	Chalmette Pet. Corp.	Chalmette	1	3,000	Winkler-Koch
S.d.	Crystal Oil Refg. Corp.	Cedar Grove	2	3,400	Jenkins
Op.	Louisiana Oil Refg. Corp.	Bossier City	9	13,500	Tube-and-tank
Op.	Shell Pet. Corp.	Norco	4	7,800	Dubbs
S.d.	do.	do.	2	2,600	do.
Op.	Standard Oil Co. of La.	Baton Rouge	22	46,000	Link
Op.	do.	do.	8	10,000	Tube-and-tank
Op.	do.	do.	2	5,000	Cross
Op.	Stanolind Oil and Gas Co.	Superior	1	2,000	do.
			51	93,300	
	MARYLAND				
Op.	Continental Oil Co.	Baltimore	2	4,000	Cross
Op.	do.	do.	4	3,000	Dubbs
S.d.	Interocean Oil Co.	do.	2	1,000	do.
S.d.	do.	do.	4	2,000	Leamon
Op.	Standard Oil Co. of N.J.	do.	4	17,200	Tube-and-tank
S.d.	do.	do.	6	12,200	do.
			22	39,400	
	MASSACHUSETTS				
Op.	Braintree Oil Processing Co.	E. Braintree	2	4,500	Doherty
Op.	Cities Service Refg. Co.	do.	2	1,800	Holmes-Manley
Op.	Colonial Beacon Oil Co., (Inc.)	Everett	8	16,000	Tube-and-tank
S.d.	do.	do.	4	8,000	do.
			16	30,300	

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	MICHIGAN				
Op.	White Star Refg. Co.	Trenton	3	3,750	Dubbs
			3	3,750	
	MISSOURI				
S.d.	Joplin Refg. Co.	Joplin	1	1,000	Jenkins
Op.	Standard Oil Co. (Ind.)	Sugar Creek	10	3,500	Burton
S.d.	do.	do.	10	3,500	do.
Op.	do.	do.	5	12,000	Holmes-Manley
			26	20,000	
	MONTANA				
S.d.	Arro Oil & Refg. Co.	W. Lewistown	1	500	Dubbs
Op.	Hart Refineries	Missoula	1	300	Own
Op.	International Refg. Co.	Sunburst	1	2,500	de Florez
S.d.	Laurel Oil & Refg. Co.	Laurel	1	1,500	Donnelly
			4	4,800	
	NEW JERSEY				
Op.	The Bertrin Pet. Co.	Maurer	1	3,000	Cross
Op.	Eastern Oil Processing Co.	Petty Island	3	4,500	Doherty
Op.	Gulf Refg. Co.	Bayonne	1	1,000	de Florez
Op.	Standard Oil Co. of N.J.	Bayonne, etc.	22	64,400	Tube-and-tank
S.d.	do.	do.	8	15,200	do.
Op.	Tide Water Oil Co.	Bayonne	5	15,100	do.
Bldg.	do.	do.	2	7,040	do.
Op.	Vacuum Oil Co. (Inc.)	Paulsboro	3	3,500	Cross
Op.	do.	do.	3	1,800	Tube-and-tank
			48	115,540	
	NEW YORK				
Op.	Sinclair Refg. Co.	Wellsville	1	4,000	Sinclair Type 600
Op.	Standard Oil Co. of N.Y., (Inc.)	Brooklyn & L. I. City	6	8,000	Cross
Op.	do.	do.	1	2,000	de Florez
Op.	do.	Buffalo	2	2,000	Cross
Op.	do.	do.	1	2,000	de Florez
Op.	Vacuum Oil Co., Inc.	Olean	2	1,000	Cross
Op.	do.	do.	1	600	Tube-and-tank
			14	19,600	

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	OHIO				
Op.	Allegheny Arrow Oil Co.	Canton	1	750	Dubbs
Op.	Gulf Refg. Co. (Del.)	Hooven	2	9,000	Own
Op.	do.	Toledo	2	6,000	do.
Op.	National Refg. Co.	Marietta	1	1,000	do.
Op.	The Pure Oil Co.	Heath	2	4,000	Cross
Op.	do.	do.	4	3,000	Gyro
Op.	do.	Toledo	4	6,500	do.
Op.	The Standard Oil Co. (Ohio)	Lima	2	1,900	Cross
Op.	do.	do.	1	7,150	Solar
Op.	do.	Cleveland	4	9,500	Tube-and-tank
Op.	do.	Toledo	2	4,800	do.
Op.	Stellar Refg. Co.	Marne	1	500	Leamon
Op.	Sun Oil Co. 1/	Toledo	2	8,000	Own
			28	62,100	
	OKLAHOMA				
Op.	Anderson-Prichard Refg. Co.	Cyril	1	3,600	Winkler-Koch
Op.	Barnsdall Refineries, (Inc.)	Okmulgee	2	4,500	Cross
Op.	do.	Barnsdall	3	4,000	do.
Op.	Beckett Co. (Inc.)	Beckett	1	1,500	Jenkins
Op.	Bell Oil & Gas Co.	Grandfield	1	1,000	Dubbs
Op.	Bilmont Refg. Co.	Garber	1	1,000	Jenkins
Op.	Champlin Refg. Co.	Enid	1	3,000	Winkler-Koch
Op.	Continental Oil Co.	Ponca City	2	4,000	Cross
Op.	do.	do.	6	9,000	Dubbs
Op.	do.	Sapulpa	6	1,500	Cross
Op.	Deep Rock Oil Corp.	Cushing	1	4,000	Dubbs
Op.	Eason Oil Co.	Enid	2	2,000	Jenkins
S.d.	Empire Oil & Refg. Co.	Cushing	2	1,500	Doherty
Op.	do.	Okmulgee	1	1,000	do.
Op.	do.	Ponca City	3	2,500	do.
Op.	do.	do.	2	2,000	Dubbs
Bldg.	Garber Refinery (Inc.)	Garber	1	2,500	Winkler-Koch
S.d.	The Globe Oil & Refg. Co.	Blackwell	1	1,000	Cross
Op.	do.	do.	1	3,000	Winkler-Koch
S.d.	Imperial Refg. Co.	Ardmore	4	2,000	Dubbs
Op.	Independent Oil & Gas Co.	Okmulgee	1	2,500	do.
Op.	Johnson Oil Refg. Co.	Cleveland	4	2,000	do.
S.d.	Marathon Oil Co.	Boynton	6	900	Slagter

1/ Estimated

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	OKLAHOMA (Cont'd)				
S.d.	Marathon Oil Co.	Bristow	3	450	Slagter
Op.	Mid-Continent Pet. Corp.1/	W. Tulsa	50	15,000	Own
Op.	Producers & Refiners Corp.	do.	3	2,500	Dubbs
Op.	The Pure Oil Co.	Ardmore	4	2,500	do.
Op.	do.	Muskogee	2	4,000	Cross
Op.	do.	do.	2	1,000	Gyro
Op.	Rock Island Refg. Co.	Duncan	2	3,000	Winkler-Koch
S.d.	Sinclair Refg. Co.	Sand Springs	4	4,000	Cross
Op.	The Texas Co.	W. Tulsa	9	15,000	Holmes-Manley
Op.	do.	do.	2	3,500	Pressure-coke
S.d.	Texas Pacific Coal & Oil Co.	Wynnewood	2	900	Dubbs
Op.	Tidal Refg. Co.	Drumright	2	5,000	Tube-and-tank
S.d.	do.	do.	5	2,500	Burton
Op.	White Oak Corp.	Allen	1	2,000	Jenkins
Op.	H. F. Wilcox Oil & Gas Co.	Bristow	1	1,100	Dubbs
			145	122,450	
	PENNSYLVANIA				
Op.	The Atlantic Refg. Co.	Franklin	6	6,000	Cross
Op.	do.	Philadelphia	10	20,000	do.
Op.	do.	Pittsburgh	2	4,000	do.
Op.	do.	Philadelphia	2	2,600	Lewis
Op.	do.	do.	4	10,000	de Florez
S.d.	Conewango Refg. Co.	Langdale	2	500	Snodgrass
S.d.	The Freedom Oil Works Co.	Coraopolis	1	500	Dubbs
Op.	Gulf Refg. Co.	Girard Point	7	19,000	Own
Op.	do.	Neville Island	1	3,000	do.
Op.	Kendall Refg. Co.	Bradford	3	2,400	Dubbs
S.d.	Penn. Oil Products Refg. Co.	Eldred	1	1,000	Snodgrass
Op.	The Pennzoil Co.	Rouseville & McClintock	3	4,500	Dubbs
Op.	The Pure Oil Co.	Marcus Hook	4	8,000	Cross
Op.	do.	do.	3	4,000	Gyro
Op.	Quaker State Oil Refg. Corp.	Emlenton	1	750	Dubbs
S.d.	Sinclair Refg. Co.	Marcus Hook	20	26,000	Isom
Op.	do.	do.	4	17,000	Sinclair Type 600

1/ Estimated.

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	PENNSYLVANIA (Cont'd)				
Op.	Sun Oil Co. 1/	Marcus Hook	10	20,000	Own
S.d.	Ultra-Penn Refg. Co.	Bruin	4	1,200	Snodgrass
S.d.	Vapor Phase Oils (Inc.)	Conewango	4	1,000	Ormont
S.d.	Waverly Oil Works Co.	Pittsburgh	1	1,000	Cross
S.d.	do.	Coraopolis	1	1,500	do.
			94	153,950	
	RHODE ISLAND				
Op.	Standard Oil Co. of N.Y. (Inc.)	E. Providence	3	6,000	Cross
			3	6,000	
	SOUTH CAROLINA				
S.d.	Standard Oil Co. of N.J.	Charleston	8	14,400	Tube-and-tank
			8	14,400	
	TEXAS				
S.d.	American Refg. Properties	Wichita Falls	2	1,800	Dubbs
S.d.	do.	do.	1	1,000	Cross
S.d.	Atlantic-Pacific & Gulf Refg. Co.	do.	1	2,500	Jenkins
S.d.	Burford Oil Co.	Pecos	2	4,800	do.
Op.	Col-Tex Refg. Co.	Colorado	1	3,000	Richmond
Op.	Continental Oil Co.	Wichita Falls	2	2,000	Cross
Op.	Cosden Oil Co.	Big Spring	4	8,000	Jenkins
Op.	Crown Oil & Refg. Co.	Houston	3	7,500	Holmes-Manley
Op.	East Texas Refg. Co.	Longview	1	3,000	Own
Op.	Empire Oil & Refg. Co.	Gainesville	2	2,000	Dubbs
Op.	Gulf Refg. Co.	Fort Worth	1	6,000	Own
Op.	do.	Port Arthur	22	55,000	do.
Op.	do.	Sweetwater	2	4,000	do.
S.d.	Humble Oil & Refg. Co.	Baytown	2	15,000	Cross
Op.	do.	do.	15	117,000	Tube-and-tank
S.d.	do.	do.	5	38,000	do.
Op.	do.	Ingleside	2	25,000	do.
S.d.	do.	McCamey	2	25,000	do.

1/ Estimated.

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	TEXAS (Cont'd)				
S.d.	Iowa Park Prod. & Refg. Co.	Iowa Park	1	1,250	Jenkins
S.d.	LaSalle Pet. Co.	Burkburnett	1	1,800	do.
Op.	Magnolia Pet. Co.	Beaumont	20	55,000	Cross
Op.	do.	Fort Worth	1	750	Controlled coil
Op.	do.	do.	1	3,000	Cross
Op.	do.	Luling	1	3,750	Controlled coil
Op.	Marathon Oil Co.	Fort Worth	6	900	Slagter
Op.	Misko Refineries (Inc.)	Mirando City	1	1,200	Own
S.d.	Motor Fuel Products Co.	Laredo	1	1,600	Jenkins
Op.	Olney Oil & Refg. Co.	Olney	1	1,000	Own
Op.	Oriental Oil Co.	Dallas	1	1,500	do.
Op.	Panhandle Refg. Co.	Wichita Falls	2	1,200	Dubbs
Op.	Pasotex Pet. Co.	El Paso	1	4,000	do.
S.d.	Petroleum Conversion Corp.	Texas City	1	600	True vapor-phase
Op.	Phillips Pet. Co.	Borger	6	7,500	Own
Op.	The Pure Oil Co.	Nederland	26	13,000	Cross
Op.	do.	do.	3	3,000	Gyro
Op.	Republic Oil Refg. Co.	Texas City	1	3,500	Winkler-Koch
S.d.	Richardson Refg. Co.	Big Spring	2	4,400	Jenkins
Op.	Shell Pet. Corp.	Houston	6	14,000	Dubbs
Bldg.	do.	do.	1	4,000	do.
Op.	Simms Oil Co.	W. Dallas	2	2,170	Cross
Op.	Sinclair Refg. Co.	Houston	7	27,000	Sinclair Type 600
S.d.	do.	do.	20	26,000	Isom
S.d.	do.	do.	3	6,500	Sinclair Type 600
S.d.	Star Refg. & Prod. Co.	Fort Worth	1	200	Fleming
S.d.	Stone Oil Co.	Texas City	1	2,000	Jenkins
Op.	Taxman Refg. Co.	Wichita Falls	1	1,500	Donnelly
Op.	Taylor Refg. Co.	Tyler	1	10,000	Rowsey
Op.	The Texas Co.	Amarillo	1	1,200	de Florez
Op.	do.	do.	1	2,000	Pressure-coke
Op.	do.	El Paso	1	1,500	Holmes-Manley
Op.	do.	Houston	1	1,000	Tube-and-tank
Op.	do.	Port Arthur	38	90,000	Holmes-Manley
Op.	do.	do.	1	2,000	de Florez
Op.	do.	do.	2	4,000	Pressure-coke
Op.	do.	San Antonio	2	3,000	Holmes-Manley
Op.	do.	W. Dallas	2	3,600	do.
Op.	do.	do.	1	2,000	de Florez
Op.	do.	do.	3	4,000	Pressure-coke
Op.	Texas Pacific Coal & Oil Co.	Fort Worth	1	1,000	Cross
			244	638,220	

Status	Company	Location	Number of units	Total daily charging capacity, barrels	Type of process
	UTAH				
Bldg.	Jenson Oil Refg. Co.	Ogden	1	1,000	Own
S.d.	Utah Oil Refg. Co.	N. Salt Lake City	30	3,800	Burton
Op.	do.	do.	2	6,400	Holmes-Manley
			33	11,200	
	WEST VIRGINIA				
Op.	Carbide & Carbon Chemicals Corp.	S. Charleston	1	800	Gyro
S.d.	do.	do.	1	800	do.
Op.	Ohio Valley Refg. Co.	St. Marys	1	750	Dubbs
Op.	The Pure Oil Co.	Cabin Creek Jct.	3	1,300	Gyro
Op.	Standard Oil Co. of N.J.	Parkersburg	1	2,800	Tube-and-tank
S.d.	do.	do.	2	3,200	do.
Op.	Tri-State Refg. Co.	Kenova	1	1,800	Jenkins
			10	11,450	
	WYOMING				
Op.	Continental Oil Co.	Glenrock	5	1,708	Burton
S.d.	do.	do.	10	2,016	do.
S.d.	Egaso Operating Co.	Osage	1	1,000	Cross
S.d.	Midwest Refg. Co.	Greybull	40	5,480	Burton
Op.	do.	Laramie	13	1,982	do.
S.d.	do.	do.	7	1,068	do.
Op.	Producers & Refiners Corp.	Parco	6	3,300	Dubbs
Op.	Standard Oil Co. (Ind.)	Casper	20	7,140	Burton
S.d.	do.	do.	30	10,710	do.
Bldg.	do.	do.	1	6,547	Continuous high-pressure
Op.	The Texas Co.	Casper	3	5,000	Holmes-Manley
Op.	do.	do.	1	1,500	Pressure-coke
S.d.	do.	Cody	1	1,500	Holmes-Manley
Op.	White Eagle Oil Corp.	Casper	1	3,000	Controlled coil
S.d.	do.	do.	1	2,000	do.
			140	53,951	

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

MINING AND TECHNOLOGY GRADUATES AND THEIR PROBLEMS [1]

By Scott Turner [2]

Since my whole life has been spent in the mining business, I naturally tend to address my remarks particularly to the newly-graduated mining and metallurgical engineers among you. To a certain extent, all forms of engineering principles are involved in the training of the mining engineer, and most sorts of engineering are certainly utilized by him, so that every one of this graduating class is concerned with the field I propose to discuss.

The fact that, beginning with to-day, you will always be styled engineers, indicates that you have passed successfully through preparatory school, and have survived the hard grind of the technical college. One object of your training here has been to instruct you in accurate, close, and clear thinking. Your minds have been taught to act directly, calmly, and always to the point. By now, you should know how to get facts, look far, and think through. You are supposed to be willing to recognize and adopt sound engineering principles and practices, in so far as they are known to you, and to furnish character, ability, and devotion to your calling.

Some of you may have had a general college course before coming here to specialize in engineering. Where that has been possible, I hope it is the case, since a liberal educational course tends to make the alumnus more flexible and adaptable than the purely scientific graduate. The broader education enables one to change, with less serious loss, from one job to another; ready adaptability is a great asset; the engineer should be capable of much more than a single special task. The necessary preliminary training for a professional occupation is intellectual in character, involving knowledge, and to some extent learning, as distinguished from mere skill. The well-balanced engineer is expected to embody a happy combination of theory and fact, of pure science and material reality; experience shows that he is apt to give a good account of himself, once he gets the chance.

For the long pull, the importance of unquestioned integrity can not be overemphasized. Leaders of big business sometimes have need for a man as agile and unscrupulous as a cat on a back fence; on occasion, they may have to employ brilliant, smart, spectacular, and crafty people, but when the special purposes for which such men are hired have been accomplished, they are no longer wanted. Given natural health, intelligence, ability, and adequate training, probably the characteristics most admired in the young employee are steadiness, dependability, and loyalty. The last is the best. If you can not be simple, direct, and faithful in your dealings with your administrative superiors, no one will want you for long.

I believe these points are of primary importance to the young engineer. Your groundwork must be right before you can get far. These personal characteristics are what eventually determine your relations with men and affairs. They are vital in the human engineering which may be a large part of your work.

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Excerpts from an address delivered to the graduating class at Michigan College of Mining and Technology, Houghton, Michigan, on June 2, 1932.

2 - Director, U. S. Bureau of Mines.

There have been many graduating classes, in many colleges. New thoughts and words appropriate to such occasions are difficult to discover, and perhaps could not be expected; the purpose may be best served by repeating and emphasizing some of the old ideas, which to you may resemble new.

No graduation address would be complete unless it contained the trite statement that leaving school does not mark the end of the education of the young engineer. This is so true, and so important, that it may well be said on every occasion of this kind. Your studies are only beginning. I hope that you already know how patiently to observe and classify facts, and that you sense the value of inference, verification, and conclusion. Doubtless you have all done some original piece of investigative work, in preparing a thesis or developing a theory, and you have already experienced the pleasure of actually unearthing some new bit of truth; you will have plenty of opportunities, and you will have further proof that this furnishes the keenest intellectual satisfaction the mind can know.

I presume you have thought about what attitude you will adopt toward your new environment outside of college halls, you have puzzled over the widening intellectual horizon that your studies have been bringing you, you are vaguely aware of the deepening faith that should come with years, that already you are struggling with the persistent problems of modern life which press upon you for solution, and that what you now would most like to know is about conditions of everyday existence, and how you can deal with its fundamental problems.

During the past decade, a great deal has been said about the accomplishments of science and engineering in the last half century. It is generally recognized that engineering is an occupation in which the amount of financial return is not the accepted standard for reckoning success. Rather, excellence of performance, advance of the profession, and service to the community are better measures. Engineering is a calling which should be pursued largely for others and not merely for one's self.

In the mining business, which on the whole is run pretty largely for the purpose of making money, similar tests might be applied in determining the amount of success attained, although the earning of a profit is here more than an incident to success, because the continued absence of profit spells failure. On the other hand, while loss spells failure, large profits do not connote success.

No one is more deeply concerned with our present economic plight than the young graduate. Even in good times, it is difficult enough to get started in the practice of your profession. Just now it may seem almost impossible. Probably no one is more puzzled than the novitiate as to the causes of our present economic situation. Although all sorts of theories are advanced, of course no one really knows. It is easy to say that we came to our high estate by highways which were tried and tested, but that now we are detouring into new and little-traveled byways, some not even paved with good intentions. It is not so easy to point out the right road, or to show how to follow it. Recently I heard an eloquent lawyer and statesman deliver an address in the course of which he said that what we needed was to go back to work; hard work was the only cure. The following night I heard a great educator, in a thoughtful speech, say that the trouble with us was that we did too much work; that more leisure should be indulged in, and that the schools and colleges must instruct the students in the cultivation and employment of leisure. Which are we to believe?

When in doubt, we are apt to fall back on first principles as taught us by our parents. I was brought up to believe in hard work, and I know what a comfort diligence and activity are in time of worry and stress. For the lack of better advice, let us stick to old doctrines, and say that salvation lies in earnest and prolonged labor and effort, in making stepping stones of obstacles. As to training in the schools, which would be better off during business depression, when competition is the most ruthless, the man who as a student had been trained to pleasant leisure, or he who had been trained to disciplined hard work? I do

not deny the value of culture, or of a certain amount of intellectual detachment for which leisure is necessary, but hard work does not exclude these.

Perhaps you can do no better than to conclude that the present, universal, sad state of economic and industrial affairs is directly or indirectly chargeable to the World War. No such wholesale destruction of life, material, and property can be carried out, with attendant overexpansion, without serious and far-reaching results. Why not just decide that we are economically sick, from excesses of various sorts, and admit that the best treatment is calm, quiet, and the passage of time, giving nature an opportunity to do as she always does, - gradually build up resistance to the malady until it is eventually overcome in a perhaps unpredictable and unexplainable but none the less natural way?

Many educators feel that students no longer believe in anything; not in the wisdom of their parents, the knowledge of their teachers, the ability of business leaders, nor the efficacy of government officials. If you feel you are losing faith in your country, hark back to the principles of industrial democracy and social justice on which our Government is founded. It may be true that modern democracies are so deficient in imagination that it is utterly hopeless, by an appeal to their intelligence, to make them visualize the logical, inescapable consequences of their course; but in analyzing the reports and rumors which abound at a time like this, you must remember that in a democracy no department of government can long escape criticism. While secretaries of departments, directors of bureaus, or the temporary incumbents of similar governmental organizations are generally exempt from personal attack, the divisions of our government themselves have been subject to continuous assault from the beginning of the Republic, often from a small minority of selfish or cantankerous people.

Perhaps faith will only come again by starting anew, living simpler, progressing slower, studying more understandingly, and working more earnestly. You, at least, will live to see the world extricate itself from the present dilemma; some of us, of one generation earlier, may not last long enough to see this economic riddle completely solved. At least, you are living at an interesting period in the world's history, and you should endeavor, at the start, to orient yourselves properly to the new order of things.

The foregoing remarks deal largely with engineering in general. Now let me say something about mining engineering. Perhaps I should briefly review the commodity field, dealing separately with each of a few common metals. Let me first suggest to you a particularly fascinating field for work and study. It is that occupied by the metal gold.

Some of you will be middle-aged, and perhaps at your technical best, when the question comes prominently to the fore as to adequacy of the then gold production to maintain monetary stocks as a basis for credit. Due to anticipated marked decrease in Rand production about 15 years hence, some time during the 1940's there may be a fairly sharp fall in annual world production, unless new and unexploited sources of supply are discovered and developed. When the increasing discrepancy between gold stocks and credits becomes more generally recognized, there will be a call for men best fitted to deal with this problem. Some of you may be ready, when that time comes.

A mining engineer should ground himself in the fundamentals of economics, banking, finance, and history if he desires to deal with such a question. If man can not get more gold, he may help in devising ways of using what we have more effectively. Some authorities insist that our credit structure must contract, which, in the absence of a great outpouring of new gold, means constantly falling prices -- hard times; I do not hold this view, and perhaps it will be one of you who will show the way to further safe credit-expansion in general support of my inference that gold has not yet been utilized fully. In an article published the end of last year I stated that -

> Although there are many who believe that in view of the existing machinery of credit the connection between the amount of gold and the level of prices is no longer direct or immediate, and there are others who even advocate the divorce of gold from its immemorial function in exchange, nevertheless there appears to be reason for supposing that gold will continue indefinitely to be the one item in monetary systems by which their other elements will be evaluated.

It is easy to point to faults in the gold standard, but it remains the best we have, or have ever had. Great Britain, in her crisis, as an emergency measure had to abandon it; the Scandinavian kingdoms did likewise; also a score of other countries have temporarily, and for pressing economic reasons, quit the gold basis. I predict that most of them will return when they can. At present the only commercially-important gold-standard countries in the world are the United States, France, Belgium, the Netherlands, and Switzerland.

It seems unlikely that the world-wide sharp fall in prices can be charged to lack of monetary gold. A result so caused would be gradual, not abrupt. It is equally in error to state that the United States in her greediness has deliberately concentrated here so much gold as to handicap the other nations. Though we now hold about 35 per cent of the world's gold, amounting to about $4,300,000,000, it has accumulated here in spite of ourselves, to balance trade, to pay off old debts, to purchase commodities, and for safe storage. Moreover, the industries of this nation are so great and productive that our gold stock should actually be large; when judged on this basis, it is by no means as excessive as many represent it to be.

Since I began my professional career, I have seen the United States gold poduction go from about $80,000,000 a year in 1904, to an all-time maximum of $99,714,800 in 1915, subsequent to which it has fallen quite steadily until, in 1930, it was only $43,419,000. See what you can do about this during the coming 10 or 15 years. The next cycle is about due; the gold boom of 1848-1852, was followed by that of 1893-1908; so it would be fine if you young fellows could bring about a third upward swing, which seems to be apt to culminate about the time you will be turning 40, and thus just getting into your best professional stride.

If you can't find more gold in your own country, or develop cheaper and better methods of mining and milling so as to make it possible to mine profitably some of our lower-grade ores, then busy yourselves in some other country and help swell the world total for the benefit of every one. You doubtless know that the benefits of metal-utilization largely exceed those of metal production. It is, therefore, a striking fact that production of gold, and of many other metals besides, anywhere in the world, is beneficial to the United States as the greatest industrial nation and the most outstanding consumer as well as producer of metals. The countries that know best how to utilize metals profit most from their possession and can therefore pay more for them than others. Hence the world first supplies their demands, and, according to their financial ability, other countries compete for the balance that remains.

Here is a good chance for some of the best of you to do useful work. In the United States, our money is backed by gold to a minimum of 40 per cent of its face value. This, however, is only the first step in the pyramiding of credit on gold. The national debt alone represents a credit, granted to our Government by investors, of over three times our supply of monetary gold. Yet, the national debt is small compared with the total of State, municipal, and private debts. Since the curve representing credits is rising at a much more rapid rate than that indicating stocks of gold, at what point will this divergence become a real menace? Thus far, gold has been able to carry the credit-load here in our own country, but within the past year we have seen half the world swept from the gold standard. Is our load

of gold and our way of managing it such that the United States gold dollar will always be impregnable? It is a theoretical question, yet a vitally important one.

Although I have first called your attention to gold, since you are here in a copper-mining region, your thoughts may turn first to copper mining, particularly in Michigan. You probably know the history of this region, its production and accomplishments, and the present state of affairs in the mines of Keweenaw Point. However, I shall summarize some of the outstanding facts. The first commercial mining, by white people, aside from a few tons found at Copper Harbor in 1844, commenced in 1845 at a point 2 miles northeast of the Ojibway mine, in what is still known as the Cliff mine. Miners, in clearing away the talus near the base of a cliff, discovered copper that led them to explore within the hill, where a 50-ton mass was struck. Subsequently, masses weighing 500 tons were discovered. The first year of recorded production for the Lake Superior district was 1845, when the total was 26,880 pounds. The year of maximum production was 1916, when the all-time record of 269,794,531 pounds, or 134,897 tons, was attained. Though production has declined since then, to the end of 1930 these mines had produced 8,382,282,360 pounds, or 4,191,141 tons of metallic copper, and the mining companies have paid $327,807,147 in dividends. Since 288,627,032 tons of ore have been treated, it is apparent that the average yield has been 29.04 pounds of copper per ton of ore.

Copper was mined at an early date in central Africa. However, it may be that the first important center of production was Cyprus, after which came Spain, Germany, Sweden, England, and Chile. From Chile the point of maximum production jumped to the United States in 1883. In this country, Michigan was at first the center of production. Thence the center moved to Montana in 1887; and in 1907 to Arizona, where it now rests. We already see signs of the passing of American copper supremacy, and it may be that within the next generation it will return to central Africa, thus completing the cycle, in about 4,000 years, by a path that embraces the basin of the Atlantic Ocean.

Northern Michigan has had a long and honorable career as a copper producer. Good mines die hard, but I presume that informed people have already warned you of the havoc low copper prices have produced here. The mines are old, and deep, the grade is relatively low; even though costs be still further lowered, and present selling price be doubled, it must be apparent to all that for the near future this region offers but limited promise to any considerable group of young mining graduates.

Your nearest neighbors are the iron mines, included within the borders of Michigan, Minnesota, and Wisconsin. Here your chances appear better, since known or probable reserves of present-grade ores are adequate for at least the most active period of your lives. You may be sure that iron mining on a large scale will be carried on in the Lake Superior region until you are ready to quit or are retired as too old to work.

Commercial iron mining started in Michigan about 1845. This state was the biggest producer until 1902, when Minnesota took the lead, which she now holds. Records indicate that Michigan has produced about 508,000,000 tons of ore to the end of 1931, valued at the mines at approximately $3,000,000,000. Minnesota appears to have produced in all about 987,000,000 tons with an at-the-mine value of about $5,500,000,000. Wisconsin makes a poor third, with all-time figures showing about 37,000,000 tons.

Most estimators concede that the Lake Superior ore reserves contain at least 1¼ billion tons. This is good for 25 years anyhow, and some think that the region has 50 years' supply of ore of the grade now being mined. The tax commissions', and other figures, pretty clearly indicate that the minimum of merchantable ore of current commercial grade existing in the Lake Superior region, is distributed about as follows:

Minnesota	1,250,000,000
Michigan	175,000,000
Wisconsin	25,000,000
	1,450,000,000

Of course, lower-grade ores exist in much larger quantities.

So, as I said before, this iron-ore region will last at least as long as you will, and it may be that you will want to do your life's work in this neighborhood.

Among the common metals, lead appears to have a promising outlook for the future. Although there has been some increase in world reserves during the past decade, the total available supply is not excessive. Under normal conditions, the production of the United States is not sufficient for the demand, so that we must import the difference from abroad. Ten to twenty years from now, our domestic lead supply may have reached a critical stage, and engineering ingenuity will be called on to increase efficiency and reduce costs so that our lead resources may be utilized to the utmost. Here is a field that should appeal to a young engineer. Opportunities for service in this industry would seem to be in the field of exploration and in increasing efficiency in the mining and milling of lead ores. Extraction in lead smelting methods has reached a point approximating perfection; however, there is still a chance for improvement in the cost of the operation.

Lead mining is one of our oldest mineral industries. According to authentic records, production began at Falling Creek, Va., in 1621. As early as 1650, lead was being mined by the English colonists in New England and by Jesuit missionaries in Arizona. Prior to the Civil War, production of lead was confined largely to the Mississippi Valley and eastern States. Our present huge production really had its beginning in 1869. In that year the famous disseminated deposits of southeastern Missouri were discovered, and the first transcontinental railway was completed, the latter permitting rapid development of the rich lead deposits of the West.

The center of production soon shifted to the western States. Colorado's output increased from a few tons in 1873 to 82,000 tons at the beginning of the twentieth century; Utah, which had produced small quantities of lead as far back as the early fifties, increased its output to nearly 50,000 tons in 1900; Idaho, after the discovery of the great deposits of the Coeur d'Alene district in 1885, raised its output to 85,000 tons in 1900. In 1908, Missouri became the leading producer of lead, a position which she still holds.

It seems likely that the lead industry will provide an opportunity for the employment of limited numbers of young engineers as soon as industrial conditions return to a normal level, and that alertness, aggressiveness, and imagination will be amply rewarded. The best prospects appear to be in the western States, where operations are on a smaller scale and where a young engineer has a wider field in which to display ability.

The zinc industry may offer a chance for those of you who are interested in metallurgy, for, in spite of great improvement during the past decade, the recovery of zinc from its ores is more wasteful and costly than the recovery of other common nonferrous metals. Recent developments indicate the need for improved extraction and for other ways of reducing the cost of producing zinc. During the past decade, there has been a substantial increase in the world's zinc reserves, particularly in foreign countries. Many of the new discoveries have been high-grade orebodies or deposits large enough to permit the use of large-scale low-cost methods. This has resulted in expansion of producing capacity and lowering of the average cost of production. The market for zinc is such that an equivalent expansion of consumption can hardly be expected. For these reasons, it is believed that in the future the price of zinc will be maintained at relatively lower levels than heretofore. If this comes to pass, our domestic producers, if they are to survive, will have to meet the new conditions

with improved technology. I have no doubt that some of your generation will contribute to the solution of this problem.

Zinc mining is perhaps the least centralized of any of our metal-mining activities. Unlike gold, silver, copper, and lead, the bulk of the production comes from the central, southern, and eastern States. The principal zinc-producing region is the Joplin district, at the junction of the three States Missouri, Oklahoma, and Kansas. The reserves of this district are still large, and with favorable prices, undoubtedly Joplin will retain its rank as the leading zinc producer for many years to come. Upon resumption of normal production, this district should provide employment for some young engineers. The substitution of large-scale-milling units for small plants has been making progress recently, and this should create a demand for more technical supervision, in order that the full efficiency of large-scale operation can be achieved.

Next in importance in zinc-yield is the State of New Jersey, where the famous mine at Franklin Furnace has been producing steadily since the middle of the nineteenth century. Another eastern State, New York, has recently become a contributor to the domestic zinc supply, and will probably be an even more important source in the future. In the South, Tennessee and Virginia have become notable producers in recent years and their outputs are likely to expand. Your neighboring State, Wisconsin, has been a source of zinc since the beginning of the century, but there has been some decline recently and it is doubtful if former production-levels will be reached again in the immediate future. Many of our western States, particularly Montana, Utah, Idaho, New Mexico, and Colorado, produce large quantities of zinc.

The reserves of zinc in this country apparently are ample for several years to come. Opportunity for useful service, therefore, would seem to be in the field of lowering the costs of production and in widening the market for zinc, rather than in seeking and developing new deposits. Those of you who enter the zinc industry may be assured of the chance for long and interesting employment.

The beginnings of the silver-mining industry in the United States are associated with two great events in mining and metallurgical engineering -- the introduction of square-set timbering for stoping large deposits, and the invention of the pan-amalgamation process for treating silver ores. The silver-mining industry has grown tremendously since those early days on the Comstock. It reached an all-time peak of nearly 75,000,000 ounces in 1915. Since then, production has declined, and in 1931 only 31,000,000 ounces were produced. This decline is associated with another more significant change in the silver industry; silver has become a by-product of the mining of copper, lead, gold, and zinc. There is little opportunity to produce silver alone, but virtually every engineer engaged in winning the common metals of the nonferrous group in the United States finds himself a producer of silver. Moreover, the revenue derived from by-product silver frequently represents the margin of profit for the operation.

One of the principal reasons for the decline and virtual disappearance in the United States of the straight-silver mines has been the fall in silver's price. This price-drop has resulted from the progressive demonetization of silver throughout the world, since Great Britain made the first move in that direction at the close of the Napoleonic Wars over a century ago. Silver needs a new use to replace its waning popularity as money.

The discovery of a new outlet for silver comparable with the monetary requirements of the past would raise the price of silver to an extent that would revive not only the silver-mining industry of the West, but would inject new life into hundreds of by-product silver mines producing chiefly copper, lead, gold, and zinc. One of you, if successful in this field, might thus become a benefactor to each of your classmates, as well as to the mining industry in general, and to the nation.

In summarizing the prospects of employment in the metal-mining industry during the next 20 years, it appears that gold mining presents the most promising field. If relatively low price-levels continue, the increasing trend of production witnessed in 1930 and 1931 may be expected to continue. This industry has probably supported more engineers than any other branch of mining, as gold mines are more numerous than any other kind.

Out of a total of 2,262 deep nonferrous metal mines operating in the United States in 1928, gold was the principal product in 932 of them. In addition, there were 1,202 placer-mining operations. So there were 2,134 gold producers out of a total of 3,464 nonferrous metal mines, including placers. Lead was the principal product in 479 mines, silver in 333, zinc in 267, and copper in 251 mines. The number of iron mines operating in the United States in 1928 was 211.

Another factor which will tend to make gold mining attractive to engineers is the ever-increasing demand for its product. It is inevitable that the gold supply must be maintained if not increased during our lifetimes, and it seems that this can only be accomplished by constantly improving methods of extraction, both mining and metallurgical, so that lower and lower grades of ores can be worked profitably. This is one of the important responsibilities of the mining engineer to society.

Copper, lead, zinc, and iron mining should require large numbers of engneers during the next 20 years, as the problems that confront these industries, particularly in the United States, are such that they will yield only to careful scientific analysis.

From the geographical point of view, I see no reason why North America should not continue to be the most important source of metals during your lifetimes. It is possible that the relative importance of the United States will diminish, but it is certain that Mexico and Canada will compensate fully for any such decline. I have just pointed out some shifts in the geographical picture, such as the increase of copper production in Africa, and you must be aware of the larger gold production in Canada. Production of lead, zinc, and copper will probably be greatly increased in our neighboring countries of the North American continent, but this should be no hindrance, as American engineers and American methods are employed the world over. Our engineers have long been oriented to the idea of service, and they have shown no hesitation about going wherever there is a job to be done, regardless of whether it is in the research laboratories of our metropolitan areas or in the jungle seeking new deposits to satisfy man's desire for metals.

To the young engineer, I urge consideration of the broader aspects of the mineral industry. The mining man is no longer concerned solely with the problem of extracting ore and producing a metal ingot therefrom. For example, these are times when mining companies are becoming more and more interested in the marketing of their products consequently the mining engineer and metallurgist has been called upon to explore the field of marketing. Research is being conducted on a large scale to find new uses for metals; likewise to improve the qualities of metals so that they may better serve the uses previously well-established. Recent developments in the chemical industry have resulted in the production of substitutes for metals; competition between the various metals increases day by day. I have no doubt that the training you have received at this institution has been broad enough that you are qualified to serve in this phase of engineering which offers opportunity for profitable service to the mineral industry.

These few references to fields of endeavor that may be open to the miners, metallurgists, geologists, and others among you, may suffice to stimulate your consideration of where and what you choose to work. While few people get what they want, still it is good to have an objective and to strive to make progress toward it. Having picked your field, or chance having given you an opportunity in a direction which you may be forced to follow, try to pause occasionally and apply certain tests to yourself, your work, and your relation to your profession and your fellow-men.

Remember that certain fundamentals are required of you before you can become good engineers in the broadest sense of the word. Are you clean, earnest, unselfish, energetic, and intelligent enough to make your way, and ultimately take your place among the leaders of your profession? Examine yourselves; try to strengthen the places in your character that you know to be weak. Cultivate and emphasize sincerity, honesty, and loyalty; keep foremost in your minds the value of character and courage, honesty and high ambition, earnestness and pride.

You young engineers should consider that you are in the world for what you can put in it, rather than for what you can get out of it. The assumption is that you have chosen the engineering profession because you believe that through it you can make the largest contribution to the common good; to accomplish this, you must be prepared to furnish accuracy, promptness, and fidelity, and to accept responsibility.

The professional man, in addition to having a certain amount of culture, must be able, when the occasion demands, to be assertive, bold, and self-reliant. If he is ambitious, at the same time he should be high-minded and proud-spirited, with the capacity for studious reflection when leisure permits.

Do not be discouraged by your apparent inadequacy. A successful man once said of another: "I am glad to join in tribute to him; I have followed his career with great interest; he is a striking illustration of how much success can be achieved in life with a limited amount of ability."

Engineering has been defined as the method whereby man shapes nature to human uses, and harnesses natural forces to human wills. In all industrial engineering, to gain success one must help to bring about advances in methods and processes, improvement of products, or perfecting of organizations; the engineer should strive to reduce friction and waste, to improve working conditions and promote happiness of the workmen, and to establish and maintain the proper relations with customers and with the community. It is pretty well understood that the great failures in the engineering profession are chargeable to want of insight into human nature, rather than to any deficiency in mastery of materials. The older you get, the more you will realize that you must comprehend your men as well as you apprehend the qualities of your substances.

The graduates of Houghton have to measure up to a high standard of excellence set by their predecessors. The competence of Houghton men is traditional, and this should stimulate you to high endeavor. Preeminence may be attained by advancing the aims, ideals, and nature of engineering, through individual initiative, courage, and spirit. My last word to you is: Be faithful to your calling, and let no difficulties impair the fineness of your work.